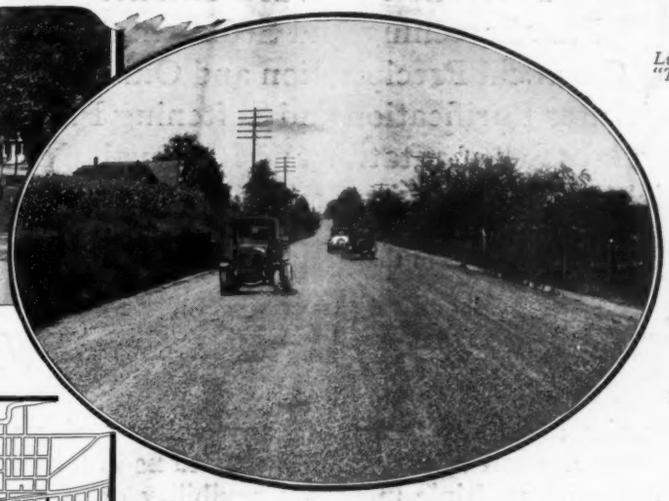
AUG 5 1922

PUBLIC WORKS

CITY COUNTY STATE

North 15th Street, Richmond, Ind.— Macadam maintained with "Tarvia-B"



Liberty Pike, Richmond, Ind.— "Tarvia-B" over waterbound macadam.

Tarvia Auto-truck Distributor

Illustrated booklets descriptive of the various Tarvia treatments gladly sent free on request.

Here's what Richmond, Ind., thinks of Tarvia—

In 1918 Richmond stepped out of the mud and dust and inaugurated a program of mudless, dustless, all-year Tarvia roads. Describing Richmond's experience with Tarvia, Mr. D. B. Davis, City Civil Engineer, writes:

"It is with considerable pleasure that I report to you our success with Tarvia. This year makes the fourth successive one in which we have used your materials.

"We have developed here a Tarvia treated gravel pavement which is so popular for residence streets that the demand each year is beyond our ability to construct. Observation of the service rendered by streets which have been surface treated during the past four years has convinced our people of the economy and serviceability of Tarvia for this purpose.

"In connection with our surface treating we repair all small depressions which occur in our 40 miles of gravel and macadam streets. A maintenance patrol is employed constantly on this work and, odd as it may seem, we have no ruts in any of our pavements."

There is a grade of Tarvia for every road purpose—new construction, repairs and maintenance.

Tarvia
For Road Construction Repair and Maintenance

New York, Detroit, Salt Lake City, Johnstown, Elizabeth, Chicago, New Orleans, Lebanon, Buffalo, Philadelphia, Birmingham, Peoria, Youngstown, Baltimore, Boston, Kansas City, Atlanta, Toledo, Omaha, St. Louis

The Barrett Company

Minneapolis, Duluth, Columbus, Jacksonville, Cleveland, Dallas, Milwaukee, Richmond, Houston, Cincinnati, Bangor, Latrobe, Denver, Pittsburgh, San Francisco, Syracuse, Washington, Bethlehem

THE BARRETT COMPANY, Limited: Montreal, Toronto, Winnipeg, Vancouver, St. John, N. B., Halifax, N. S.

AUGUST, 1922
V. 53. No. 6

DORR

Dorr Equipment

has been selected for plants of the following types:

Activated Sludge
Separate Sludge Digestion
Protection of Water Intakes
Fine Screening and Sedimentation
Chemical Precipitation and Oxidation
Water Purification and Softening Plants
Straight Sedimentation and Removal of Solids
Trickling Filters with Secondary Sedimentation

in the treatment of

Municipal Sewage and Factory Wastes

Dorr units are built to handle any volume of sewage or waste, and are self-adjusting to fluctuations in flow. Plants may comprise multiple units for flexibility or to provide at small expense for further growth, with individual units sized according to normal flow conditions.

Dorr Equipment minimizes operating cost and attendance. Little power required. Uniform results assured. Sightly and nuisance-free plants. Continuous mechanical operation.

The Dorrco Screen Unit
delivers low moisture screenings directly into cans for final disposal.

The Dorr Sewage Clarifier
delivers a sludge of lower moisture content than can be obtained in any ordinary sedimentation tank.

Bulletin No. 20 contains full descriptions and data.
Send for your copy.

The Dorr Company

Engineers

Sanitary Engineering Department
101 Park Avenue
New York

Denver **London**

DESIGN **TESTS** **RESEARCH** **EQUIPMENT**

VOL. 53 NO. 6

Entered as second-class matter at the Post Office, at New York. N. Y., November 22, 1921, under the Act of March 3, 1879.
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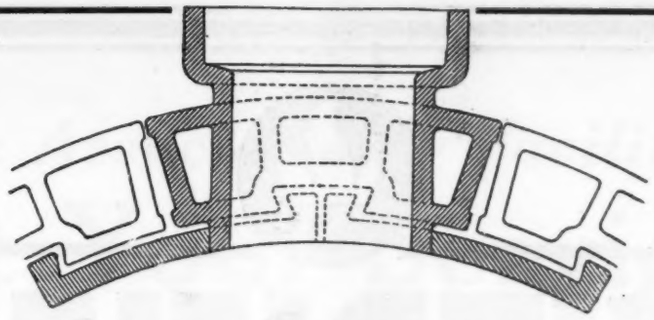
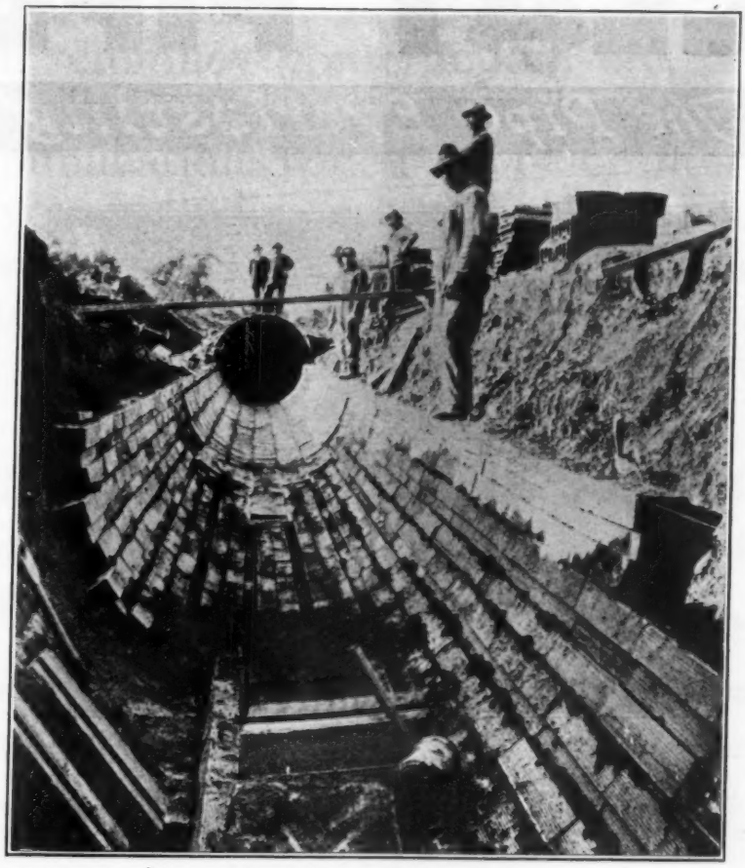


ROBINSON
SEGMENT SEWER BLOCK



A WATER TIGHT SEWER

Maximum resistance at the point of the greatest stress.

Joints are made in such a manner as to secure the most perfect bond; all joint faces are deeply scarified.

A water-tight sewer, owing to the irregular continuous mortar joint between the inner and outer courses.

A great saving in cost of excavation in firm ground.

There is no chance of error in line or grade if the ROBINSON SYSTEM of laying is used.

Curves of small radius can be laid with great rapidity.

Ten plants enable us to handle the largest contracts and to give prompt and efficient service.

We are ready at all times to quote prices in sizes from 30″ to 108″ inclusive.

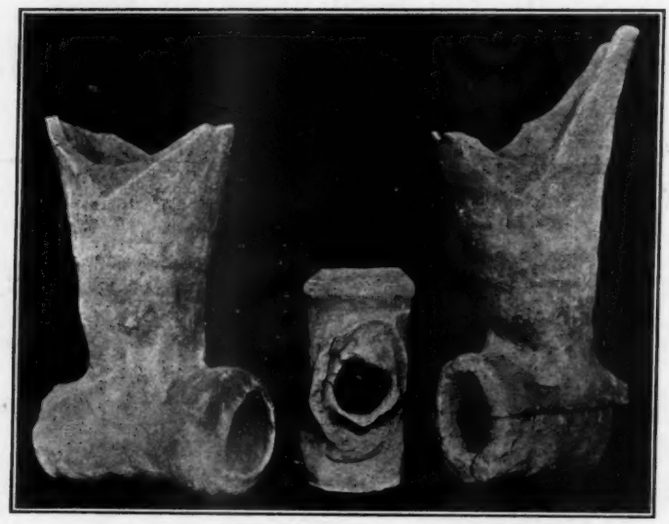
Robinson Clay Product Company

Akron, Ohio

TESTED BY FIRE

VITRIFIED CLAY PIPE

The Pipe Everlasting



6000 Years Underground

Clay pipe unearthed from the ancient city of Babylon in a perfect state of preservation. These specimens may be seen in the museum at the University of Pennsylvania.

The assertion that vitrified clay pipe is the best material for conveying sewage and ground water is supported by the result of tests and years of service—under all sorts of conditions, and in all parts of the world.

IMPERISHABLE WITH TIME

The Association's Facilities

At Your Service

Our engineers are ready at all times to give you information regarding the manufacture and use of vitrified clay products, embracing sewer construction, chimney construction, etc. We have ready for distribution a number of publications which will be of interest to you, including a handbook on house sewers and house drains. Let us know your problems.

For Full Particulars write

Eastern Clay Products Association

Henry T. Shelly, Secy., Mgr. :-: **Phone Spruce 5029**

910 Penn Square Building, Philadelphia, Pa.

Members Eastern Clay Products Association

The Buckeye Fire Clay Co., Uhrichsville, Ohio

Cambria Clay Products Co., Blackfork, Ohio

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Crouse Clay Products Co., Akron, Ohio

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Evans Pipe Co., Uhrichsville, Ohio

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Robinson Clay Product Co., Akron, Ohio

Ross Clay Products Co., Uhrichsville, Ohio

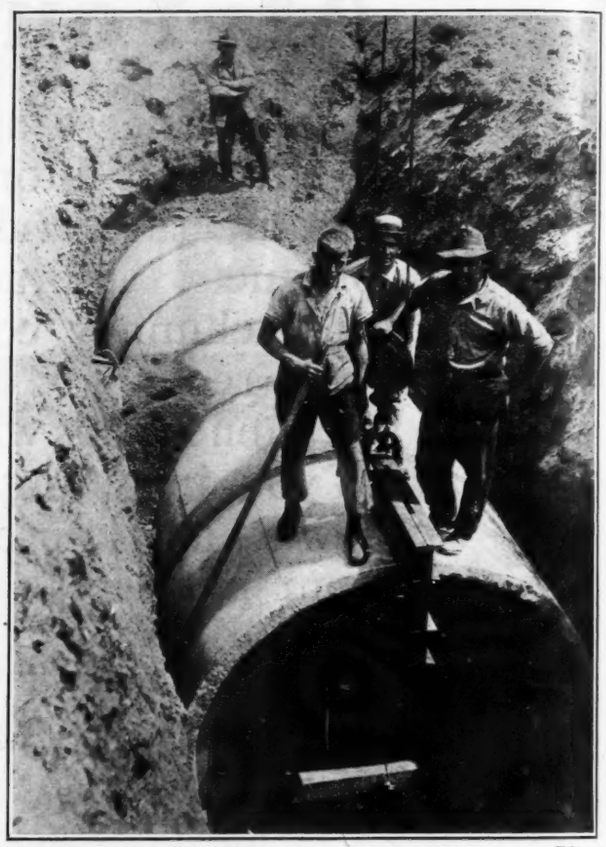
St. Mary's Sewer Pipe Co., St. Mary's, Penna.

Uhrichsville Clay Co., Uhrichsville, Ohio

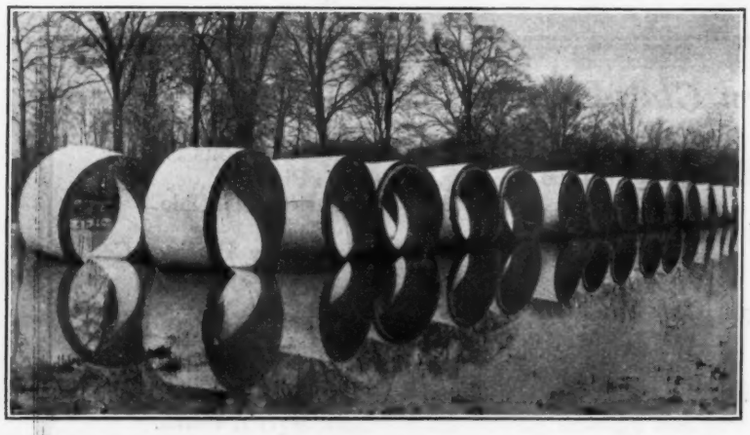
Wolf-Lanning Clay Co., Dennison, Ohio

STRENGTH—DUR

ENGINEERS throughout the country are striving for a strong, permanent sewer construction for their municipal improvements, and they have recognized that REINFORCED CONCRETE PIPE is rapidly meeting their desires in this respect. They feel they can depend on REINFORCED CONCRETE PIPE to give their community a lasting sewer. They know that frictional resistence is less. They know that REINFORCED CONCRETE PIPE is adaptable to most all of their projects and that it results in considerable economy.



Installation of 78″ Independent Reinforced Concrete Pipe for Northeastern outlet, Pontiac, Michigan. Note method of laying pipe.



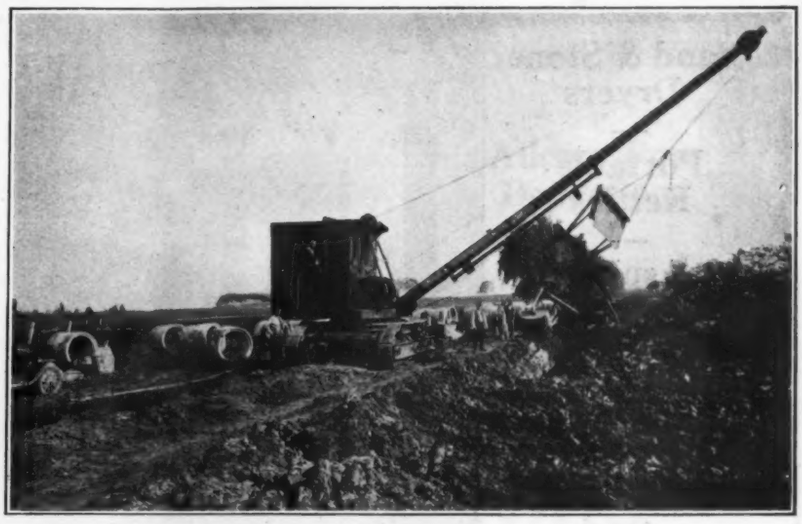
72″ pipe built for the City of Muncie, Indiana. Note how pipe is placed along line of trench ready for contractor to lay.

They realize that Concrete Pipe is true to shape; provides smoothest flow line; gives maximum service and carrying capacity. They also understand that the contractors installing REINFORCED CONCRETE PIPE have many advantages when they use this class of material.

CONCRETE PIPE

RABILITY—SPEED

They realize that the contractor can lay REINFORCED CONCRETE PIPE faster and cheaper than any competitive material, thereby giving the City in which REINFORCED CONCRETE PIPE is installed a better product at a more reasonable price. When leading Engineers are beginning to recognize this fact, can we say more than for you to investigate the using of REINFORCED CONCRETE PIPE in your next project?

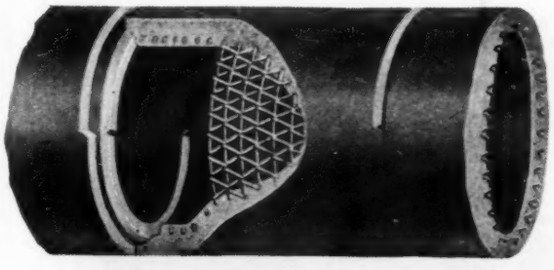


Concrete Pipe supplied to the City of Kenosha, Wisconsin. Note pipe placed along line of trench and ease in excavating and backfilling.

Independent Reinforced Concrete Pipe

has all of the qualities of competitive materials and has a great many additional advantages.

Write us for illustrated booklet. Get in touch with our Engineering Department and let us point out the advantages of using REINFORCED CONCRETE PIPE.



Our joint insures a strong, durable and water-tight connection. It is the most economical in time, labor and mortar—a saving to the contractor and a satisfaction to the Engineer.

EASIER TO LAY—CHEAPER TO LAY—FASTER TO LAY

INDEPENDENT CONCRETE PIPE CO.
INDIANAPOLIS, IND.

FOR PERMANENCE

ASPHALT PAVING PLANTS

PORTABLE
SEMI-PORTABLE
STATIONARY

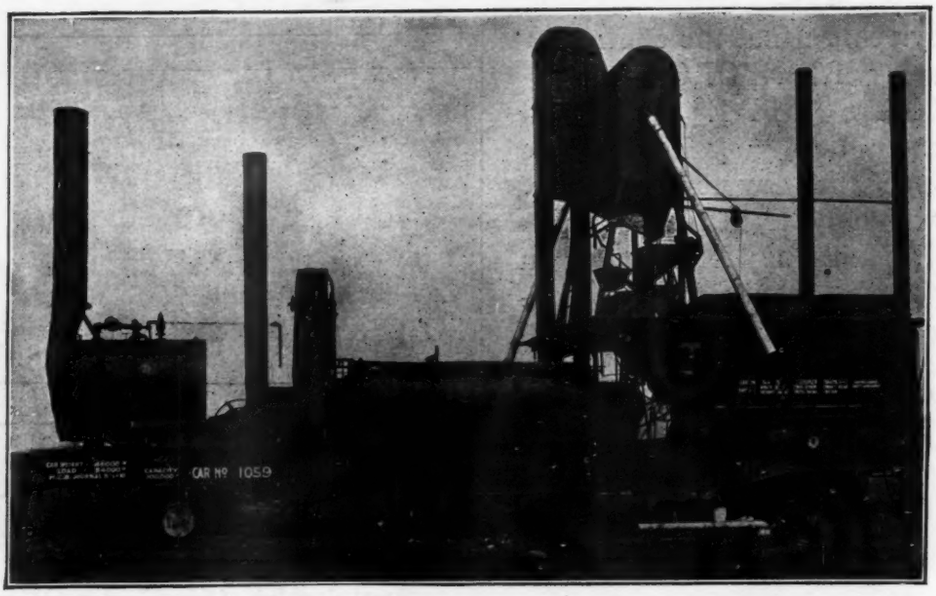
Sand & Stone Dryers

Portable Kettles

Asphalt Street Tools

Brick Testing Rattlers

Gravel Pumps etc.

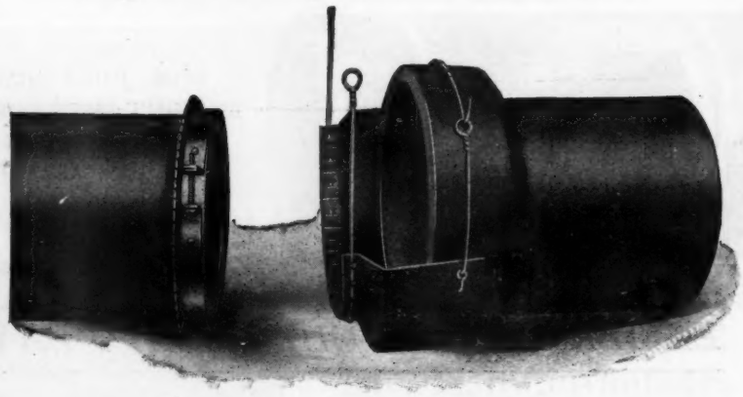


HETHERINGTON & BERNER
INDIANAPOLIS, IND.

New!

A Tight Joint and perfect alignment by common labor

WESTON
PIPE GASKETS AND FORMS

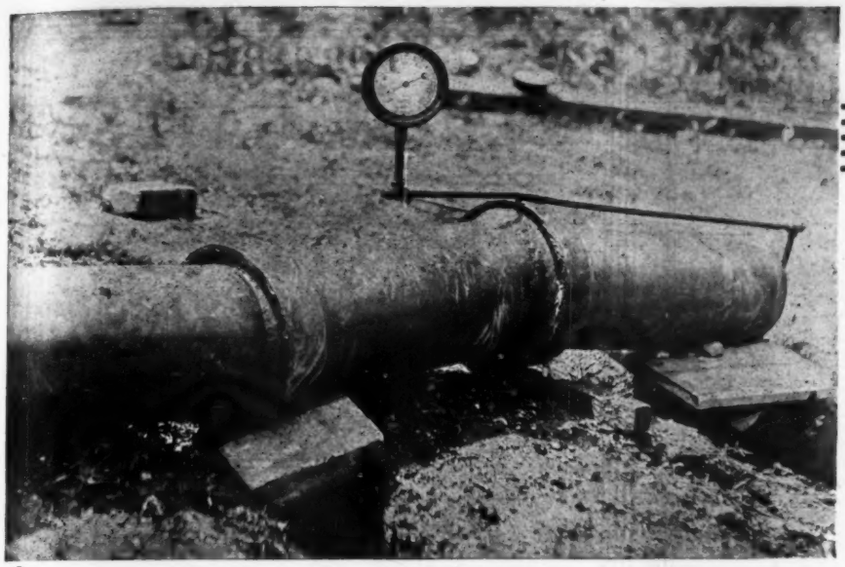


With this gasket and form you can quickly determine the proper pouring of cement by inspection. The joints can be made in trenches containing water and with water running through the pipes, provided the depth of the water is not more than half the inside diameter of the pipe. An excessive amount of pumping or sub-drainage is thus avoided.

The use of this device also permits partial back-filling of the trench before the joints are made, thus promoting proper alignment of the pipe and preventing the breakage of the joints during backfill. It also precludes the penetration of roots into the sewer.

Full information will be sent to any interested official upon request.

L. A. WESTON, ADAMS, MASS.



Allows For Deflection

G-K Flexible Pipe Joint Compound

"The Original Water Tight Sewer Joint Compound"

has an adhesive strength of 90 lbs. per sq. in. on vitrified tile.

Will allow for deflection of pipe line due to soft subgrade and heavy backfill—and remain watertight under pressure.

Guarantees the life of the pipe, as bell will not be broken if grade is disturbed from any cause.

An Absolutely Water Tight Joint Which Will Stay Tight

Tests were made by Bureau of Surveys, Philadelphia, Pa., and pressure carried to 85 lbs. per sq. in. on 12-in. tile pipe and no leakage at joint.

Vitrified tile pipe, 8 in., subjected to 30 lbs. pressure for 15 minutes and no leak.

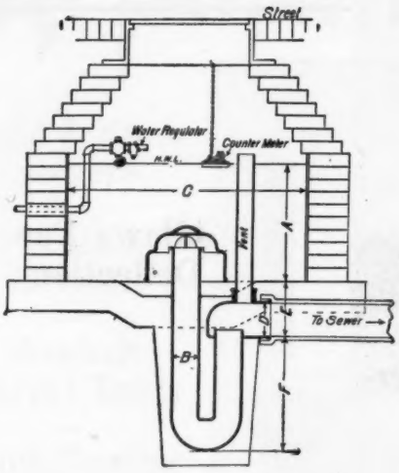
This means that the Sewer Dept. will not have the trouble and expense of removing roots, and treatment costs reduced materially by the elimination of ground water of infiltration.

COST DATA WILL BE FURNISHED UPON REQUEST.

G-K SALES AGENCY

MACUNGIE, PA.

MILLER SIPHONS



The Miller Standard Siphon has no fussy parts to be broken or misused. It has no moving parts. It is easy to set, as there are but two parts fitted and readily installed. No subsidiary devices or tubes, nothing to break. We can furnish Miller Siphons in any size from 3″ to 30″ and for any desired drawing depth. Single siphons, also double, triple and plural alternating siphons, designed to fill any requirement for operating sand filter, contact bed, sprinkling filter, and domestic sewage treatment plants.

JOINTITE

A SEWER PIPE JOINT COMPOUND

No caulking is necessary with JOINTITE. Alternate joints may be poured on the bank. Easily handled and placed. No skilled help required. Sets as soon as poured. Adheres to the pipe.

PACIFIC FLUSH-TANK CO.

149 Broadway **New York**

6 CATALOGS

on Airlock Apparatus for Sewers and Sewage Disposal

Catalog No. 15—Flush tank Siphons, Water Regulators
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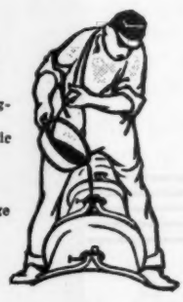
Catalog No. 21—Pneumatic Sewage Ejectors
Catalog No. 12—Sewer Pipe Joint Compound
Catalog No. 14—Automatic Siphons for Large Municipal Disposal Plants, etc.
Catalog No. 7—Imhof Tanks

Catalogs mailed on request



SLUICE GATES

Shear, Flap and Butterfly Valves

FLEXIBLE JOINTS

Write for Literature

COLDWELL-WILCOX CO.

Box 574 **Newburgh, N. Y.**

D&D

SAFETY and NOISELESS Manhole Cover

Does away with rattling or dishing

Our foundries and machine shops are equipped to handle work on a production scale. No order too large or small.

A large stock of stock patterns on hand and prompt deliveries assured. Special castings of soft gray iron from drawings or blueprints. We can also machine any castings to size.

Full particulars on request—send for catalogue.

WM. E. DEE COMPANY

30 N. La Salle Street **Chicago, Ill.**

Manhole, Catch Basin and Sewerage Castings of All Kinds. We Make Anything in Gray Iron Write for Our Prices

DIRECT

OXIDATION DISPOSAL

CORPORATION

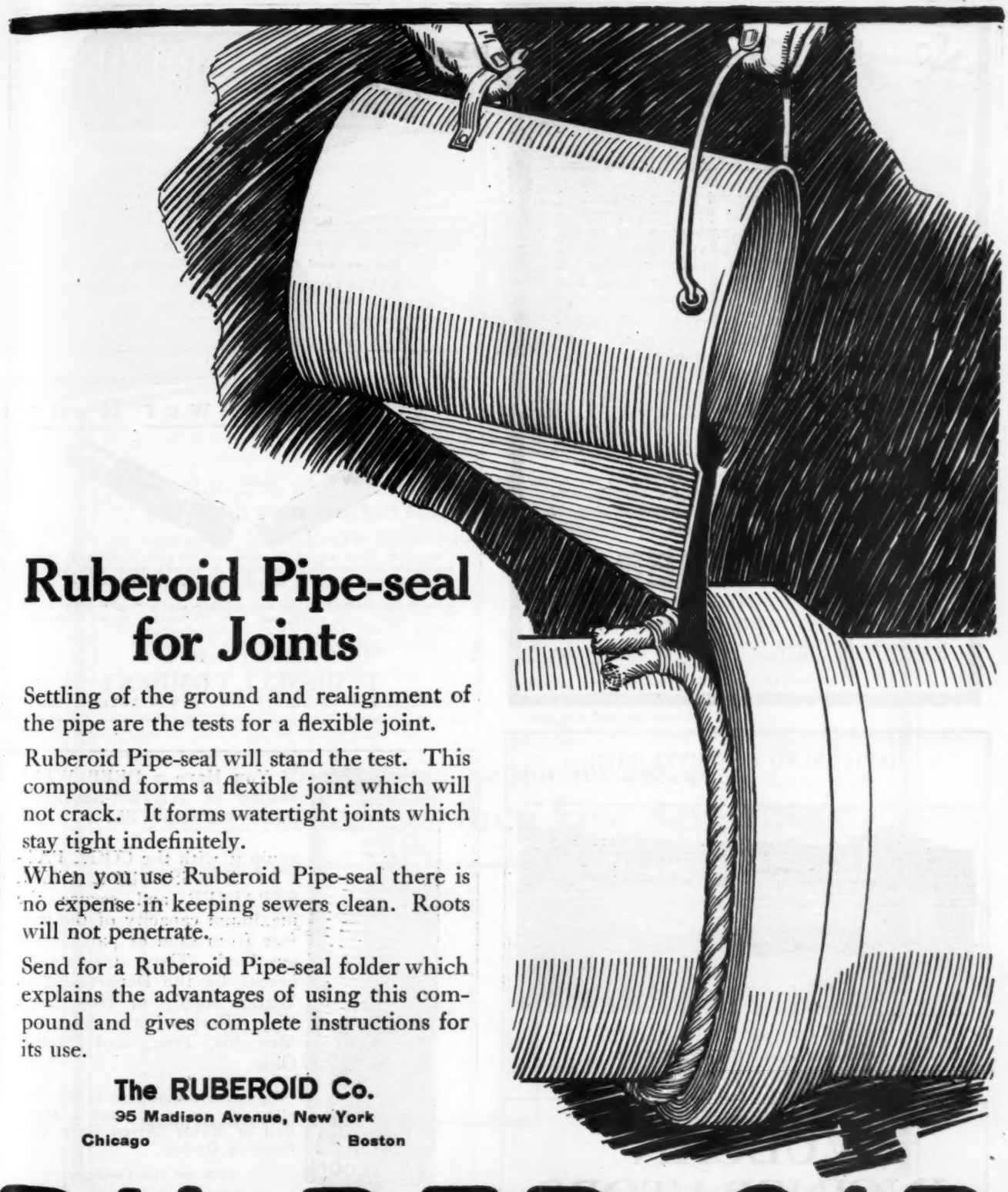
LAND TITLE BUILDING
PHILADELPHIA

POSITIVE AND DEPENDABLE SEWAGE PURIFICATION
BY THE DIRECT OXIDATION PROCESS

Flockhart Foundry, Newark, N. J.,
is the largest manufacturer of sewer and highway castings in the United States. We ship 700 tons monthly—handling 98% of the business in Greater New York and shipping as far west as San Diego, California.

Your inquiries for manhole heads, inlet basins, etc., singly or by hundreds are requested.

MAIN OFFICE, 83 POLK STREET, NEWARK, N. J.



Ruberoid Pipe-seal for Joints

Settling of the ground and realignment of the pipe are the tests for a flexible joint.

Ruberoid Pipe-seal will stand the test. This compound forms a flexible joint which will not crack. It forms watertight joints which stay tight indefinitely.

When you use Ruberoid Pipe-seal there is no expense in keeping sewers clean. Roots will not penetrate.

Send for a Ruberoid Pipe-seal folder which explains the advantages of using this compound and gives complete instructions for its use.

The RUBEROID Co.
95 Madison Avenue, New York
Chicago **Boston**

RU-BER-OID
Pipe-seal

Another
RIEFLER FEATURE

The improved spring method of joining the pen, pencil, needle point or lengthening bar to the dividers eliminates the need of a set screw, thus overcoming the inconvenience of its being lost and stripping thread.

This simple method of attachment adds greatly to the neatness and finish of these instruments and insures greater accuracy.

In the last half century our repair department has never had occasion to adjust this socket joint.

Write for Catalogue P.W. describing Riefler's complete line of precision drawing instruments.

For your protection be sure F. W. Co. is stamped on each instrument. Not genuine without.

F.WEBER CO
Drawing Materials
1220 Buttonwood St.
Philadelphia
St. Louis, Mo. Baltimore, Md.

It Carries More Water for Its Diameter Than Any Iron Pipe

WYCKOFF WOOD PIPE is not impaired by the effects of electrolysis acid fumes or corrosion. It is light, strong and very durable. Lengths, 6 feet to 12 feet long. Size for size, it carries 14 per cent. more water than iron pipe. Costs less for transportation because it is lighter and easier to handle.

May we send Catalog giving fullest details?

A. WYCKOFF & SON COMPANY, Elmira, N. Y.

H. H. White - - 1503 Fourth Natl' Bank Bldg., Atlanta, Ga.
Johnson-Peters Co. - - - - Pittsburgh Terminal Warehouse, Pittsburgh, P- 551 West 14th Place, Chicago, Ill.

Security Sewer Rods

Security Rods are made from second-growth hickory, with malleable iron couplings swedged or shrunk down very tightly on the curved places at end of sticks. Security couplings cannot come off.

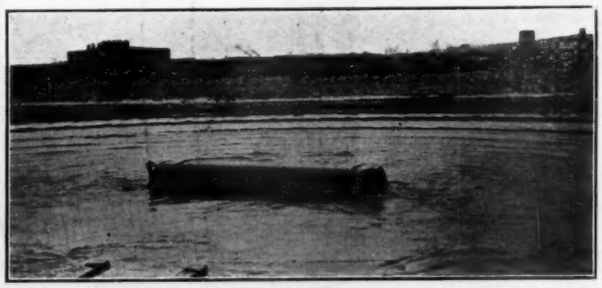
Joint and unjoint easily and quickly—light weight—long runs easily made. No slack, but lend themselves to all practical bends.

They cannot buckle or uncouple in the duct.

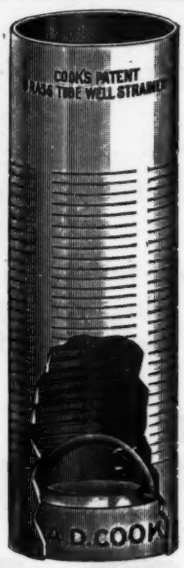
Send for Flyer No. 20

F. BISSELL COMPANY
226-228-230 HURON STREET TOLEDO, OHIO

REINFORCED CONCRETE PIPE
FOR ALL PURPOSES



UNITED CONCRETE PIPE CO., INC.
29 BROADWAY, NEW YORK CITY



If You Have a DEEP WELL ending in WATER-BEARING SAND OR GRAVEL.

equip it with the COOK PATENT BRASS TUBE WELL STRAINER and secure the maximum capacity of the well free from sand or particles of any kind. These strainers are in use by the Department of Water Supply of New York City, Parkersburg, W. Va., Memphis, Tenn., and Dayton, Ohio.

Upon the completion of the well, allow me to quote upon a Steam Belt or Motor Driven Deep Well Pumping Outlet.

Write for New Catalogue

A. D. COOK, Manufacturer Lawrenceburg, Ind., U. S.

VULCAN INCINERATORS

The McCanse System for Municipalities

ODORLESS AND SMOKELESS

The Most Economical

VULCAN INCINERATOR CO.
SECURITY BUILDING ST. LOUIS

"STEWART SEWER CLEANING MACHINE"
"Used in Nearly Every State in the Union"

SEWER RODS

We pay freight and ship for trial. Who else will do it?
W. H. STEWART

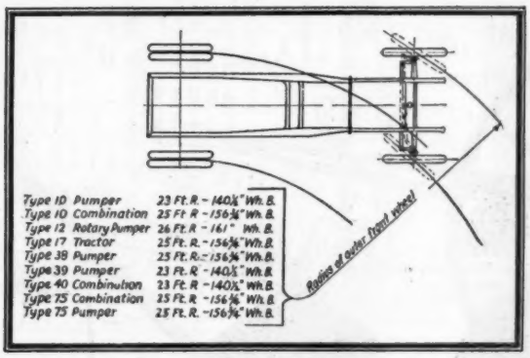
1614 Locust Street, St. Louis, Mo.
133 George Street, Boston, Mass.

In this fire at Norfolk, Va., eleven American-LaFrance pumpers gave perfect service, one engine having a record of seventy-two hours continuous service.

IMAGINE such a fire as the one illustrated, where the Chief must use his experience to marshal his forces like a military commander in battle, shifting his fighters and equipment to meet the varying attack of the on rushing fire. It is in situations such as this that the Chief is thankful for every detail of design that makes his work easier

In carefully planning the big details American-LaFrance engineers have not overlooked the smaller but equally important points that go to make American-LaFrance Motor Fire Apparatus the standard of the world.

One Reason for the Success of
American LaFrance Fire Apparatus


Type 10 Pumper 23 Ft. R. - 140¾" Wh. B.
Type 10 Combination 25 Ft. R. - 156¾" Wh. B.
Type 12 Rotary Pumper 26 Ft. R. - 161" Wh. B.
Type 17 Tractor 25 Ft. R. - 156¾" Wh. B.
Type 38 Pumper 25 Ft. R. - 156¾" Wh. B.
Type 39 Pumper 23 Ft. R. - 140¾" Wh. B.
Type 40 Combination 23 Ft. R. - 140¾" Wh. B.
Type 75 Combination 25 Ft. R. - 156¾" Wh. B.
Type 75 Pumper 25 Ft. R. - 156¾" Wh. B.
Radius of outer front wheel

The Short Turning Radius

Congested streets accompany every fire. Excited onlookers, nervous drivers, intent firemen, all heedless of everything but the immediate demand of the instant In such a turmoil the ease with which fire apparatus can change location is of prime importance. The short turning radius of American-LaFrance motor apparatus permits movement with the least amount of confusion and enables your operator to take advantage of every opening. It is a means of saving precious seconds when every second counts.

AMERICAN-LAFRANCE FIRE ENGINE COMPANY, INC.

BRANCHES
NEW YORK
BOSTON
ATLANTA
PITTSBURGH
CHICAGO
DALLAS

ELMIRA, N.Y.
CANADIAN FACTORY
TORONTO, ONT.

BRANCHES
DENVER
MINNEAPOLIS
LOS ANGELES
SAN FRANCISCO
WASHINGTON
PORTLAND

Keeping City Streets Clean

IRON HORSE Street Cleaners and Scrapers are familiar sights on the streets of a large number of progressive cities all over the country. And scores of other municipalities are adopting *Iron Horse* Street Cleaning Equipment and Metalware yearly, as they have come to rely on its wear-resisting quality and the fact that it continues to give faultless service long after ordinary equipment has been relegated to the scrap heap.

You will be interested in our complete *Iron Horse* Metalware Catalog No. 921, showing our complete line, beautifully illustrated in color. *Write for your copy today.*

ROCHESTER CAN COMPANY
ROCHESTER, N. Y.

ANNOUNCING A NEW CUSHION TRUCK TIRE

Copyright 1922, by The Goodyear Tire & Rubber Co., Inc.

At the left is seen the famous All-Weather Tread and the Indented Sidewall of the new Goodyear Cushion Truck Tire. Right—a cross-section showing the Goodyear Patented Hollow-Center

Goodyear has produced a new cushion truck tire embodying both the original Goodyear Hollow-Center cushion and the famous All-Weather Tread.

It unites in one tire the resilience of the cushion, the wearing quality of the solid, and the tractive power of the All-Weather Tread.

It is a development of the standard Goodyear Hollow-Center Cushion Tire, more than 30,000 of which have been proved in actual service during the last five years, and it is a distinct advance on that splendid tire.

The new Goodyear All-Weather Tread Cushion Tire has a pressed-on base that defies base-separation troubles.

Its tread is the powerfully tractive All-Weather Tread design, insuring sustained headway under all road and weather conditions, saving fuel and engine strain by its sure gripping.

Its triple cushion design makes it a real shock absorber, resilient beyond any other tire excepting the pneumatic. It has the advantage of the patented hollow center, the high, thick blocks of the All-Weather Tread, and a new sidewall pattern that permits easy compression under pressure.

Resilient, tractive and long-wearing, this tire assures thousands and thousands of miles of efficient and economical performance at low cost per tire mile.

The new Goodyear All-Weather Tread Cushion Tire is made in all standard sizes, up to and including 7 inches, and is specified for all-'round equipment on light and medium duty vehicles and as front wheel equipment for the heaviest trucks.

GOODYEAR MEANS GOOD WEAR

GOODYEAR

For Brick Pavements

TEXACO Asphalt-Filled brick pavement on Main Street, Galesburg, Ill., constructed in 1913.

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Sludge Digestion Tanks at the Baltimore Sewage Works

By C. E. Keefer*

Sedimentation and sludge digestion tanks cheaper to construct and to operate than Imhoff tanks, less troublesome, and give equally as good results. Sludge digestion is being used in future development of Baltimore plant. History of this feature of the Baltimore works.

The sewage treatment plant of Baltimore is receiving the sewage from approximately 550,000 people. This sewage is domestic in character and amounts to nearly 50 m. g. d. In order to prevent it from creating a nuisance, treatment units costing approximately $3,000,000 have been constructed. As the population of the city, according to the 1920 census, was 733,826, and as sewers are being extended at the rate of almost two miles a week, there is no doubt but that the sewage flow will increase materially for the next few years. To provide for this additional flow, more treatment units will have to be constructed.

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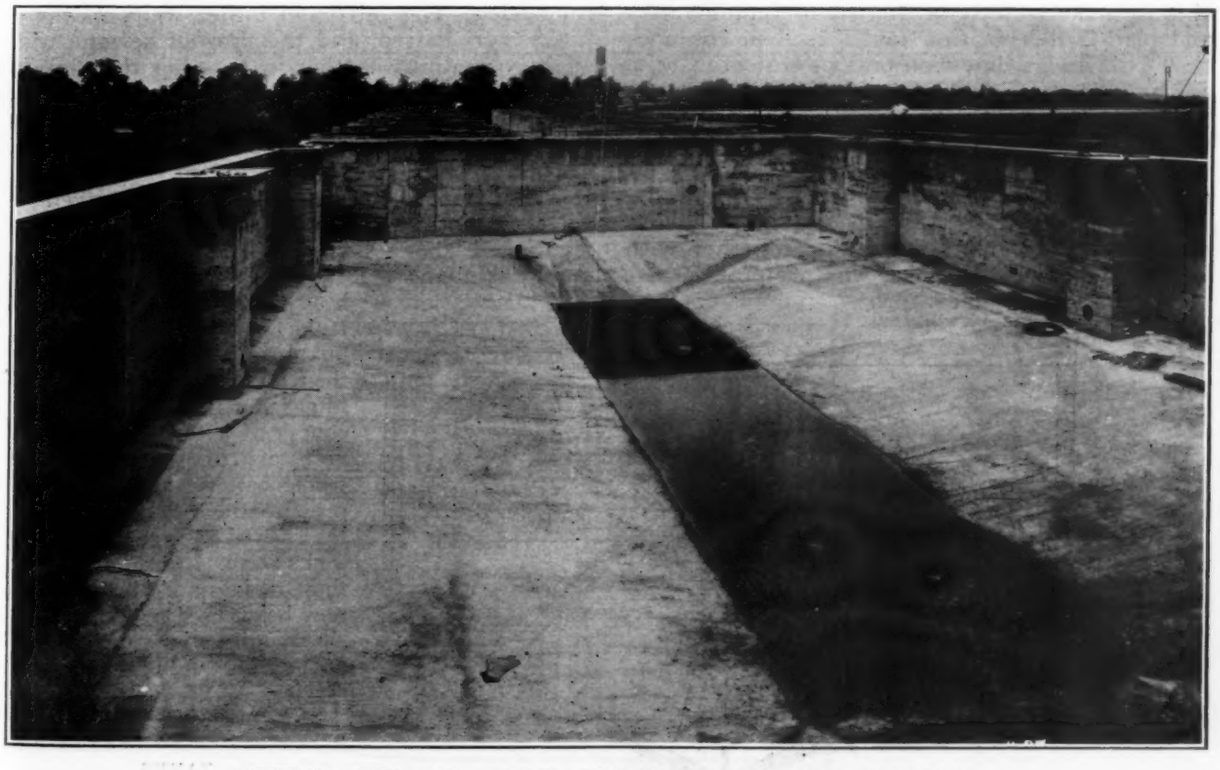


INTERIOR VIEW OF SLUDGE DIGESTION TANK NO. 20, BUILT 1921
Tops of old circular sludge digestion tanks seen immediately beyond. Sludge beds seen faintly at the left

GENERAL DESCRIPTION OF PLANT

The sewage works are situated on a tract of land containing 468 acres, which was purchased in 1906. The various types of tanks, filters, and sludge drying beds cover approximately 45 acres of ground, and plans are being prepared to materially increase the size of the plant. The sewage, which averaged, in 1921, 252 p.p.m. of suspended solids, first flows through a bar screen house where large floating matter is caught and removed. From the screen house it passes through four Venturi meters to sedimentation tanks, of which there are four at present. From the sedimentation tanks the sewage flows through revolving screens to 30 acres of trickling filters. After leaving the trickling filters it continues to two final settling basins, from which it passes through water turbines to Back river.

SLUDGE DIGESTION TANKS

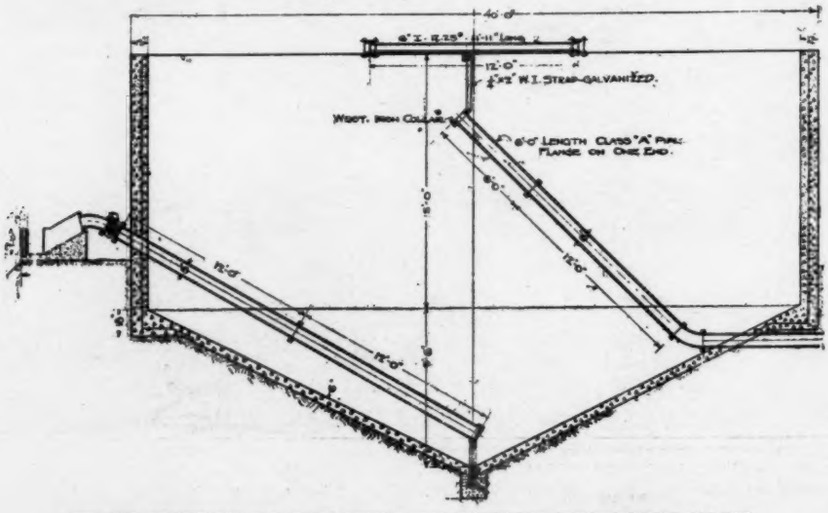
The sludge from the sedimentation tanks is pumped to sludge digestion tanks, where it remains for a period of from three to six months. At the end of this time the amount of organic matter in the sludge has decreased by gasification and liquefaction, and is sufficiently stable so that it can be dried on sludge beds in a comparatively short period of time. There are 7.6 acres of these beds where practically all of the sludge from the plant is dried. Some of this air-dried sludge is carted away by farmers, but the larger portion of it is heat-dried and sold as a base for fertilizers.

SEDIMENTATION TANKS VERSUS IMHOFF TANKS

Baltimore has been very fortunate in being able to make a study of the use of Imhoff tanks and plain sedimentation tanks used in conjunction with sludge digestion tanks. Unfortunately, the experience with the 28 circular Imhoff tanks has not been what was anticipated when these tanks were built. The Imhoff tanks have been in operation continually for several months at a time, and even when they were giving satisfactory service, it is safe to say that the use of the four sedimentation tanks, together with the sludge digestion tanks, was preferable.

In reaching the solution of a problem of this sort, the economics of the question is often a deciding feature, and it has been found that at Baltimore it has cost considerably more to treat the sewage when Imhoff tanks were used as compared to treating the same sewage through plain sedimentation tanks and sludge tanks. The reason for this is easy to explain. First of all, Imhoff tanks of any depth are much harder to construct. The excavation must be carried to greater depths. Heavy concrete construction is necessary. With the building of plain sedimentation tanks these conditions do not exist as a general thing. When it comes to the operating of Imhoff tanks, a good deal of supervision is necessary in order to keep them running in a satisfactory manner, and it is undoubtedly true that there are several installations where Imhoff tanks are not giving satisfaction even where the greatest degree of supervision is exercised. Gassing and foaming are likely to occur at any time due to causes which very often are unknown; at least, such has been the case at Baltimore.

Not long after the Imhoff tanks at Baltimore were put in service they began to give trouble due to foaming. They had been in operation approximately a year when it was necessary to shut them down. It was apparent to those familiar with the conditions that the troubles encountered were chiefly due to two causes: first, the sludge storage space in the tank was inadequate, and, second, the hydraulics was poor. In May, 1919, two of the twenty-eight tanks were remodeled. The inlet and outlet weirs of these tanks were raised, and the flow of sewage was slightly modified so that in entering the tank it flowed over the top of the weirs instead of passing downward through openings in the bottom of the inlet channel. These two tanks worked very satisfactorily for a period of over a year. It was then decided to remodel the other twenty-six tanks in the same way that the two tanks mentioned above had been changed. As each tank was changed it was put in service, so that by January, 1921, eighteen tanks were in use. For some unknown reason, first one and then another of them started to gas and foam, so that in the course of a few weeks it was necessary to shut down the whole battery, and up to the present time they have not been used as sedimentation tanks at all. Instead of having these tanks stand idle, they are now being used temporarily as sludge digestion tanks, and are giving very satisfactory service.



CROSS-SECTION OF OLD TYPE OF SLUDGE DIGESTION TANK

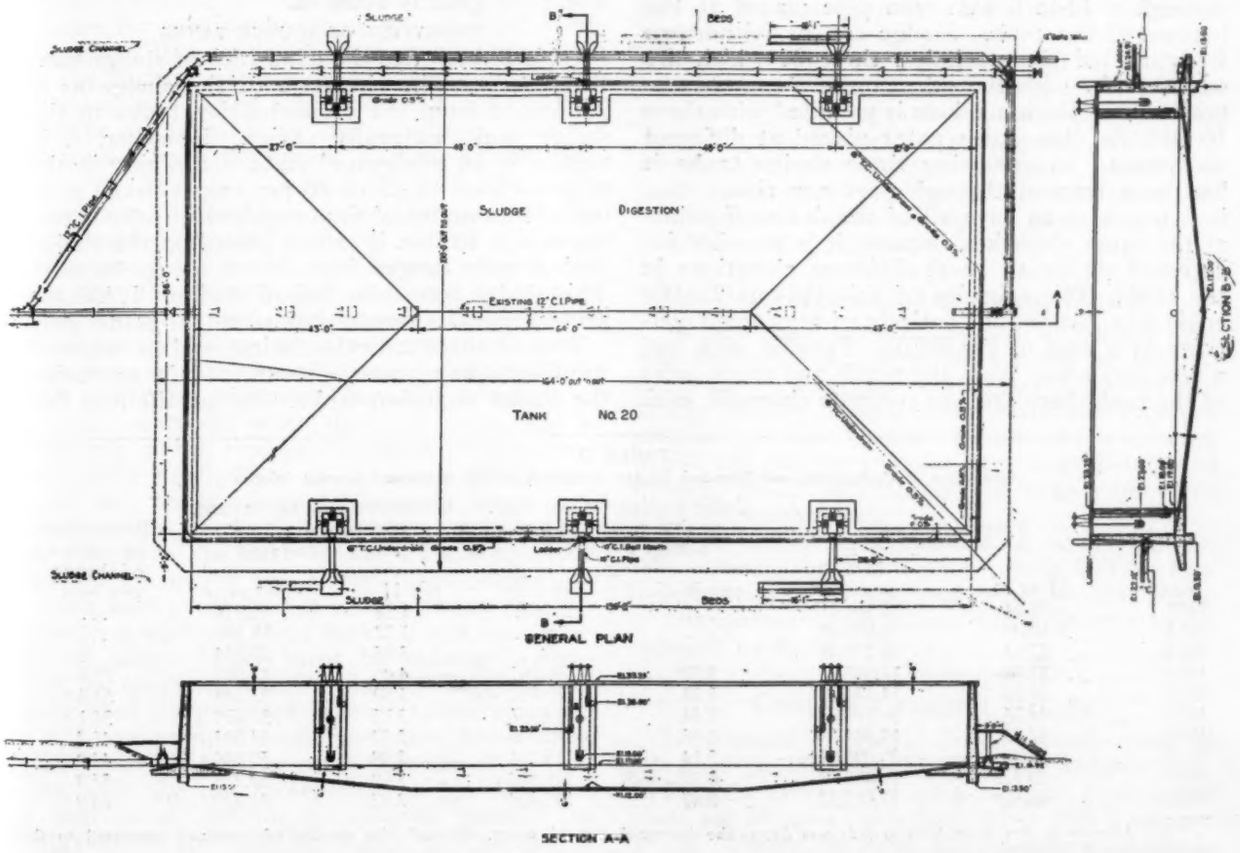
OPERATION OF SEDIMENTATION TANKS

There are four sedimentation tanks, each having a capa-

city of 3,800,000 gallons. They are alike with the exception of a few minor details. Each of these tanks is 420 feet long, 103 feet wide, with a depth varying from 10½ to 15½ feet. In the summer months they are kept in operation for a period of about ten days before they are cleaned, whereas in winter they are operated continuously from three to six weeks. As soon as a tank is put out of service, the supernatant is pumped to one of the other tanks in operation, and then the sludge is pumped into one of the sludge digestion tanks. The length of time required to move this material varies considerably with the quantity in the tanks and the amount of moisture it contains. If these tanks have been in operation only about ten days, the total time required to clean them does not take longer than four or five days. On the other hand, if they are run for a month or six weeks this amount of time is greatly increased. The tanks are cleaned by flushing the sludge with streams of water to channels, from which it flows by gravity to centrifugal pumps. These pumps are used to lift the sludge to the sludge digestion tanks.

DESIGN OF SLUDGE TANKS

The first three sludge tanks, Nos. 1 to 3, built at Baltimore were rectangular in shape, 140 feet long, 103 feet wide and from 13½ to 15½ feet in depth. Sludge is fed into these tanks through a cast iron pipe line which is attached along the top of the walls opposite the outlets of the tanks. In order to prevent odors from escaping when raw sludge is fed into the tanks, short removable pieces of pipe, which extend below the surface of the sludge in the digestion tanks are attached to the main sludge pipe. Each tank was provided with three manholes, at the bottom of which are 12-inch sluice gates, one for each manhole. The manholes are connected by a conduit to a small pumping station, which is equipped with a 10-inch centrifugal pump. When these tanks were designed, it was anticipated that as the sludge was fed into them it would gradually digest and settle to the bottom of the tanks, leaving a layer of water at the top. On the top of the walls of these tanks a small rectangular conduit was constructed for removing this water. This conduit, however, has not been used for several years, as the water never collects on the surface of the sludge. The reverse condition of what was anticipated has taken place. As the sludge remains in the tanks, gas action naturally begins, and material is forced to the surface, which in the course of time becomes dry and hard. There have been times when this scum has been sufficiently hard and thick to support the weight of workmen. In order to get the sludge to the pump it is necessary to break it up with a stream of water so that it will flow through the conduits. The capacity of the above tanks amounts to 608,700 cubic feet. It very often happens that undigested sludge flows directly underneath the scum to the outlets. About a year ago additional out-



PLAN AND VERTICAL SECTIONS OF NEW SLUDGE DIGESTION TANK

let points were built at higher elevations in the manholes, and should undigested sludge be found at one elevation, the chances of getting digested sludge from one of the other points are increased.

In 1915, when more sludge digestion space was needed, sixteen more tanks, Nos. 4 to 19, were built of an entirely different design. All of these tanks are of the same size and shape. They are 38 feet in diameter and 24½ feet deep. The bottoms are hopper shaped, the depth of the hopper being 9½ feet. It was thought that these tanks would behave in the same way as the rectangular tanks were supposed to act, namely, that the digested sludge would form at the bottom, while the undigested material would remain at the top. One inlet pipe and one outlet pipe was provided for each tank. The inlet pipes are 8 inches in diameter, terminating near the top of the tank. The outlet pipes are at the bottom. Unfortunately, the digested sludge accumulates at the top of the tank, with the undigested material at the bottom. These tanks evidently cannot be operated as easily as might be the case if these pipes had been placed in the reverse positions.

Sludge Tank No. 20, which was the last one built, was completed in September, 1921. When this tank was designed, several features not a part of the old tanks were added. This tank is 150 feet long, 86 feet wide, with a depth varying from 16 feet 3 inches to 21 feet 3 inches. Sludge is fed into the tank at opposite ends through a 12-inch cast iron pipe placed at the bottom of the tank. Sludge can be withdrawn from one of six manholes, three of which are on one side, with the other three along the opposite side. Each manhole is provided with three 10-inch circular sluice gates placed at different elevations. In operating these sludge tanks it has been learned through past experience that it is not wise to have all of the draw-off points at the same elevation, because it is possible for digested sludge to be at different elevations in the tank. The capacity of this tank is 233,000 cubic feet. It is built entirely of reinforced concrete at a cost of $58,881.04. Parallel with and a few feet away from the north and south sides of the tank there are two concrete channels, each 1 foot wide and 1 foot 6 inches high. The digested sludge is drawn from the tank into these channels, and from there to the sludge drying beds. As it is difficult to get sludge to flow in very long open channels, it is planned to use cast iron pipe lines in the future for carrying the digested sludge to the drying beds.

Table I gives the cost and capacities of the sludge tanks at the Baltimore plant.

TABLE I

Cost of Sludge Digestion Tanks at the Baltimore Sewage Works

Sludge Digestion Tanks Nos.	Year Built	Cost	Capacity, Cu. Ft.	Cost per Cu. Ft.
1-3	1909-1910	$43,311.00	608,700	7.1c
4-19	1914-1915	27,240.80	329,700	8.3c
20	1920-1921	58,881.04	233,000	25.2c*

* Increased cost due to high prices after the war.

SLUDGE PIPE LINES

As in the design of Imhoff tanks, it is as essential, if not more so, to have pipe lines of sufficient size through which the sludge can be pumped or made to flow from one tank to another. All of the pipe lines used for carrying sludge at the Baltimore plant vary from 8 to 12 inches in diameter. The main feeders are all 12 inches in diameter. A few of the distributing pipes to the tanks are 8 inches in diameter. The present practice is to use 12-inch pipes for main distributors, with 10-inch pipes for short branch lines. By using pipes instead of channels the amount and intensity of odors that would be created is greatly reduced.

OPERATION OF SLUDGE TANKS

Table II indicates the quantities of sludge handled yearly. The character of the sludge as it is pumped from the sedimentation tanks to the sludge tanks naturally varies. However, it is usually in an undigested state, containing in the neighborhood of 65 or 70 per cent volatile matter. The amount of time required to fully digest the sludge so that it can be placed on the sludge drying beds ranges from three to six months. This sludge resembles Imhoff sludge. It has the same general characteristics and dries as well.

Two or three entirely distinct and pronounced conditions have been encountered in operating the sludge digestion tanks. During the first few

TABLE II

Quantities of Undigested and Digested Sludge Produced at the Baltimore Sewage Works

	Flow of sewage		Cubic yards of 90 per cent. moisture undigested sludge produced		Cubic yards of 90 per cent. moisture digested sludge produced		Reduction in volume of sludge per cent.
Year	M. G. D.	M. G. per year	per M. G.	per year	per M. G.	per year	
1912	11.90	4,320 85	...	.....	1.52	6,568	...
1913	18.06	6,597 48	...	.....	1.72	11,348	...
1914	22.93	8,372.09	...	.....	3 85	32,233	...
1915	31.80	11,607.41	5.70	66,165	4.05	47,010	29.8
1916	39.16	14,374.00	5.53	79,488	3.69	53,040	33.3
1917	44.35	16,199 83	7.34	118,907	3.15	51,029	57.1
1918	52.82	19,284.78	6.06	116,866	3.32	64,025	45.2
1919	55.04	20,096.08	5.14	103,294	2 98	59,886	42.0
1920	52.12*	19,074.23	6.37	121,503	3.00	57,233	52.9
1921	46.62*	17,015.72	8.47	146,403	3.02	51,420	64.9

* The decrease in flow from 1919 to 1921 was due to the decreased use of water, although the number of buildings connected to the sewerage system increased.

years that the plant was run only a very thin scum formed on the top of the sludge tanks; and as there was plenty of sludge storage space, no difficulties were encountered. But as the quantity of sludge began to increase with the increasing flow of sewage, the scum on the tops of the tanks began to get thicker, with a moisture content less than 70 per cent at times. To get this sludge to flow through the pipe line, large quantities of water had to be added. The top layers of sludge not only contained less moisture but they also were more thoroughly digested.

This condition continued until September, 1921, when some very stale sewage was placed in one of these tanks and immediately violent gas action began, so that in the course of a few weeks it seemed as though the contents of the tank had been completely churned up. Instead of a heavy scum on the surface, the top layer contained a great deal more moisture than formerly, and gas action was noticed practically over the whole surface of the tanks. This sludge could not only be run through the pipe lines more easily, but it also digested much quicker and dried on the sludge beds more readily. As soon as one tank reached this condition, sludge from it was pumped to the other two rectangular tanks, and before cold weather all three of the rectangular tanks were gassing violently and were giving more satisfactory results. Unfortunately, cold weather prevented this condition from continuing, and the present lack of digested sludge for seeding purposes has at least partly prevented this condition from starting up again in the spring and continuing. As soon as additional sludge tanks are completed, every effort will be made to have this condition continue at least during the major portion of the year.

ODORS

Sanitary engineers are beginning to realize more and more that not only should a sewage treatment plant give a satisfactory effluent, but also that the odors produced should be reduced to a minimum, and many ways have been devised for curtailing these nuisances. Undoubtedly the sponsors of the activated sludge process have a strong argument for such a means of sewage treatment when they can show that in disposing of the sewage the odors produced are practically negligible. It has been thought by some that the storing of sludge in large open tanks would create considerable odors. Such has not been the case at the Baltimore plant. The sludge on the top of the tanks forms into a thick heavy mat, and it is safe to say that the odors coming from these tanks is less than from Imhoff tanks. Care must be exercised, however, in operating such a plant to see that the undigested sludge is not exposed to the air when it is being pumped from one point to another.

The belief is held by some that the chief difficulty with the use of separate sludge digestion is that it is difficult to remove quickly the sludge from the settling tanks to the sludge tanks. The results obtained at Baltimore indicate that it makes little difference if the sludge in the settling tanks is removed within a few hours or a month after it has settled out. It is true that after a tank has been in service for a long period of time its settling efficiency decreases. However, at Baltimore it has been possible to maintain a 65 per cent removal of settling solids even when the tanks are cleaned only once in six weeks.

PLANS FOR THE FUTURE

At the present time designs are being prepared for three sludge tanks having a capacity of 610,000 cubic feet. In all probability, many new features not tried out before either at Baltimore or at any of the other sewage treatment plants where sludge digestion is used, will be introduced. In the light of present day knowledge with reference to sewage treatment, it is likely that the future extensions to the plant will be of the same general character as those that have been built in the past. Although Imhoff tanks have given satisfaction at many places, the use of sedimentation tanks in conjunction with sludge digestion tanks has given good results at the Baltimore plant and is to be preferred to Imhoff tanks. It costs less to construct and operate a plant of the former design, and the settled sewage and sludge obtained are as good. In view of the fact that two of the largest sewage treatment plants in the world, namely, the one at Birmingham, England, and the other at Baltimore, have given such good results, there is much to be said for the use of plain sedimentation tanks in conjunction with sludge digestion tanks.

H. G. Perring is chief engineer of the Department of Public Improvements. The sewage treatment works are under the supervision of A. E. Christhilf, highways engineer, with M. J. Ruark, division engineer of sewers. The writer has charge of the design and construction of additions and extensions to the plant, and J. W. Holden is the superintendent.

War Material for Road Work

Surplus war material valued at $139,773,996 was delivered to the states for use in Federal Aid road construction up to July 1. Except five of the smaller states, every state has received supplies of this kind to an amount exceeding $1,000,000. Motor vehicles have been distributed totaling 29,325, in addition to a large number of tractors, trailers, etc.

There is still a large quantity of material in this country for distribution which will be further increased by material used by the Army of Occupation in Germany, which is soon to be brought back.

Cost of Grading Roads

The Bureau of Public Roads recently reported that road grading costs have reached a stable basis. In 1917 the average cost for grading on Federal Aid roads was 38 cts. a cubic yard, but in 1920 it reached 66 cts. During the three months ending August 1, 1922, the average price per cubic yard for the whole United States was 33 cts.

St. Louis Water Works Operation

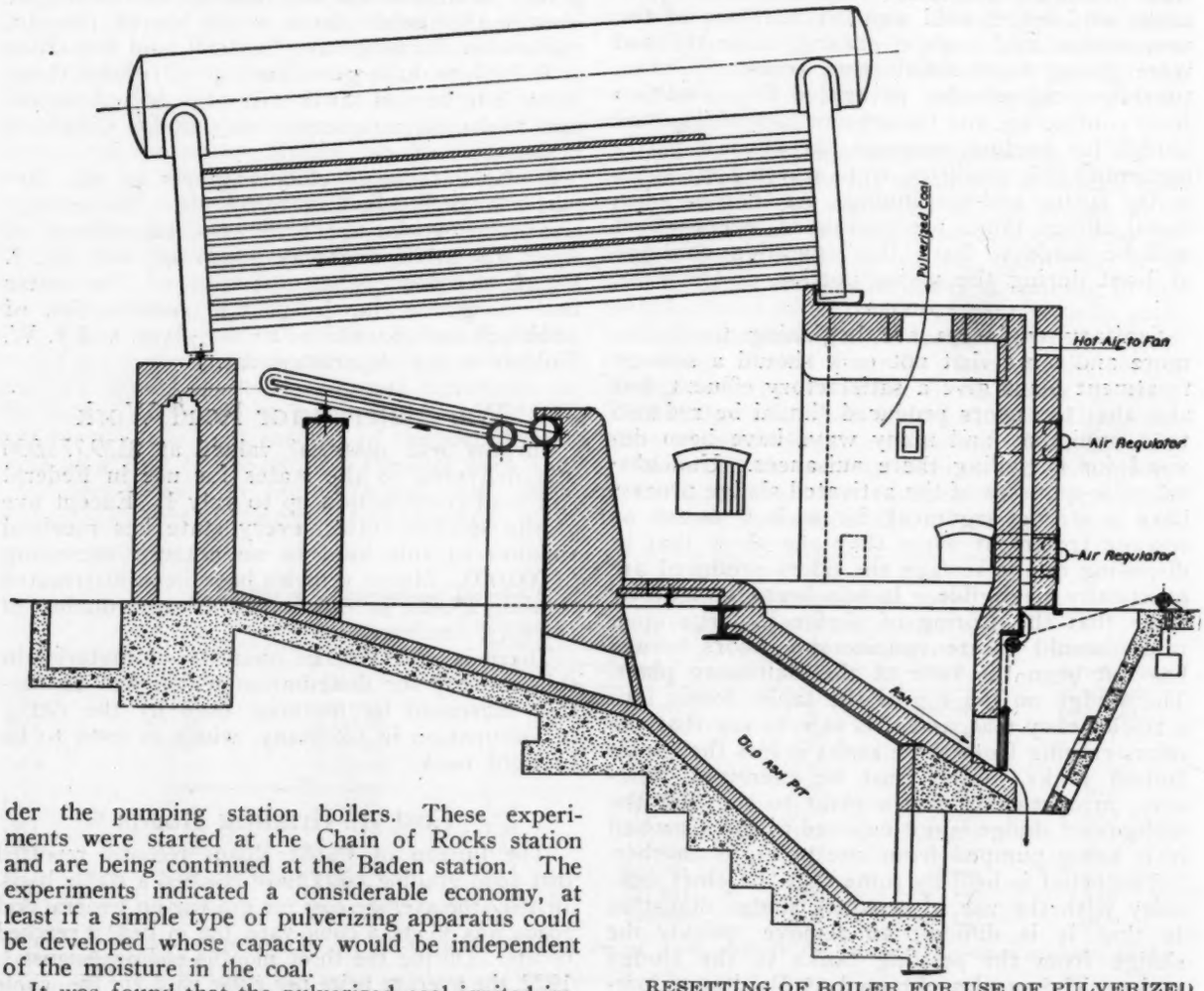
Improvements in use of fuel, effected and contemplated. Some features of proposed pumping and purification plant. Cement gun for removing coating from filter sand. Disc harrow for cleaning mixing conduits. Cleaning 195 miles of mains. Some features of metering. Average and maximum consumption rates

The St. Louis water works, one of the largest and most efficiently operated in the country, developed little that was out of the ordinary in its operation during the fiscal year of 1921-22, but in several respects increased the efficiency of its operation and conducted a number of experiments and tests with a view to introducing improved methods in the future. Also, plans were perfected for the new water works which are to be located on the Missouri river about 8 miles above St. Charles.

USE OF PULVERIZED COAL

One of the interesting experiments conducted as a basis for future improvement in operation was made with a view to learning the desirability and best method of using pulverized coal as a fuel under the pumping station boilers. These experiments were started at the Chain of Rocks station and are being continued at the Baden station. The experiments indicated a considerable economy, at least if a simple type of pulverizing apparatus could be developed whose capacity would be independent of the moisture in the coal.

It was found that the pulverized coal ignited immediately upon entering the furnace and combustion showed a possible carbon dioxide content of the flue gases of from 14 per cent. to 15 per cent., a high ratio when compared with the theoretical maximum of 17.9 per cent. for the coal used. An analysis of the unconsumed carbon in the ashes showed less than 6 per cent. combustible in the ashes, representing a loss of less than 1 per cent. of the total heat value of the coal. Present average operating conditions show a carbon dioxide content of the flue gases of about 10 per cent. and an unconsumed combustible in the ash of about 15 per cent., representing about 3½ per cent. of the total heat value of the coal. These two, the flue gas loss due to excess air and the ash pit loss due to unconsumed combustible, represent respectively about 50 per cent. and 10 per



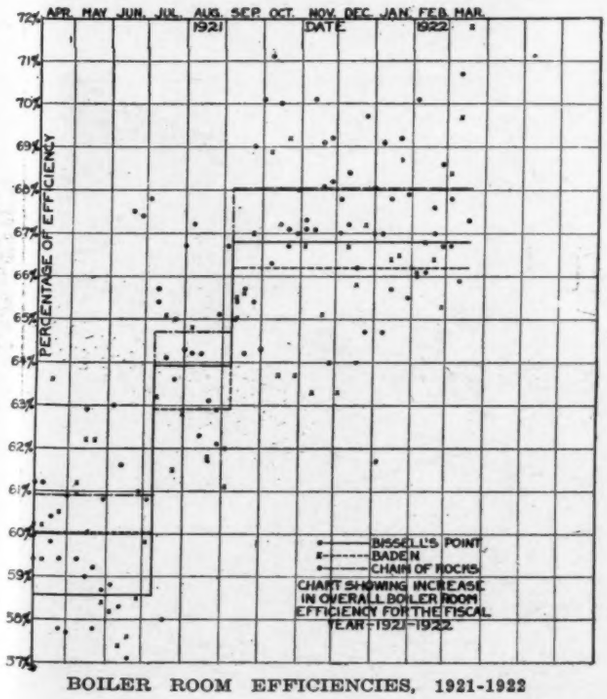
RESETTING OF BOILER FOR USE OF PULVERIZED COAL

cent. of the total losses of a present average good boiler setting with the common methods of firing, and the value of making a saving in these becomes very apparent.

Because of the very short periods that the pulverized coal firing apparatus was run at a combustion rate of less than two pounds of coal per cubic foot of combustion space, no conclusions could be drawn regarding the life of the furnace; but when a combustion rate of about three pounds of coal per cubic foot of combustion space was attempted, the furnace burned out completely in less than a day. An approximate heat balance showed that over 20 per cent. of the heat in the coal was lost in radiation through the walls of this furnace. With these results, and the furnace destroyed beyond repair, it was decided to rebuild under a Baden station boiler, the high setting of these boilers lending themselves far better to the adaption of a proper furnace. The illustration shows the new setting in longtudinal section.

CHANGE IN BASIS OF COAL CONTRACTS

A better grade of coal was used during the year, which result was secured by receiving bids on the basis of a guarantee of both B. t. u. value and percentage of ash, bids being compared on the basis of the B. t. u. delivered for one cent, this value being obtained by dividing the B. t. u. in the coal released for steam making by the price per ton plus freight plus hauling and unloading cost. In paying for the coal, the B. t. u. value for one cent was obtained as above but omitting the freight, hauling and unloading charges from the divisor, and this value was then used in determining the price per ton from the analyzed B. t. u. and ash content of the coal. The B. t. u. released for steam making in the type of furnaces in use was found to be about (100% minus half the ash per cent.) times the total B. t. u. of the coal. During the seven months this method was in operation the B. t. u. varied from a maximum of 11,277 to a minimum of 9,199, averaging 10,460; while the ash percentage ranged from a maximum of 24.1 to a minimum of 9.0, with an average of 15.2.



BOILER ROOM EFFICIENCIES, 1921-1922

The diagram shows the overall boiler room efficiency for the past fiscal year. The new coal is considered to be mainly responsible for the increase during the later months because of the low percentage of ash secured by the new specification. The ash averaged over 21% during April, May and June which, with combustible in the refuse of about 25%, incurred an ash pit loss of 10% of the heat in the coal. The ash of the coal delivered under the new contract averaged 15% and the combustible in the refuse about 15%, giving an ash pit loss of 3½% of the heat in the coal. The net resulting gain is about 6½% in the heat available for making steam, and assuming the heat absorption or efficiency of the boiler to be increased proportionately accounts for much of the increase shown in the diagram. The lines in the chart show a rise in efficiency for July and August, which was due to the fact that coal was obtained from the Duquoin district, which is superior coal to that previously used. The increase in September was due to the new form of contract, coal deliveries under this contract having been begun in that month.

NEW PUMPING PLANT

The new pumping plant to be constructed on the Missouri river already referred to is designed for a total capacity of 200,000,000 gallons daily and it is proposed to equip the plant with eight boilers, each of about 1,000 horsepower capacity, set high, with large combustion chambers that will accommodate either forced draft stokers or the burning of pulverized coal. The boilers will be equipped with superheaters and probably with economizers. Boiler efficiencies of 75% and over are to be anticipated, and to obtain the highest possible overall plant efficiency, the steam pressure and the temperature will be chosen as high as modern practice permits for the types of pumping units considered. It is proposed to use somewhere between 250 pounds gage pressure with 150 degrees superheat and 300 pounds gage pressure with 200 degrees superheat.

For the low-pressure pumps the turbine-driven, geared, centrifugal type of pump will be chosen as lending itself best for handling the raw sandy water. High-pressure units will be either the triple expansion, crank and fly wheel pump or the steam turbine-driven, geared, centrifugal pump, or a combination of the two.

The size of the high-pressure pumps and that of the pump conduit or rising main are inter-related. This rising main leads for 45,000 feet to the Stratmann Hill reservoirs. The friction head will, of course, vary with the size of this conduit and the annual steam cost will vary correspondingly—that is, the larger the main the less the friction head and the less the cost of steam and also the size of pump. A larger main will, of course, cost more than a smaller one, while decrease in the size of pump will reduce the cost of both purchase and operation. Consequently there will be a certain size of conduit and corresponding size of pump which will give a minimum total annual cost. Studies of this indicated

that the size will be somewhere between 66″ and 78″ diameter of main, depending mainly upon whether the steam cost will be approximately $.20 or $.40 per 1,000 pounds of steam. For a conduit having a diameter of 72″, the average between these limits, the total head on the pumps would be 351 feet, about 75 feet of which would be friction head.

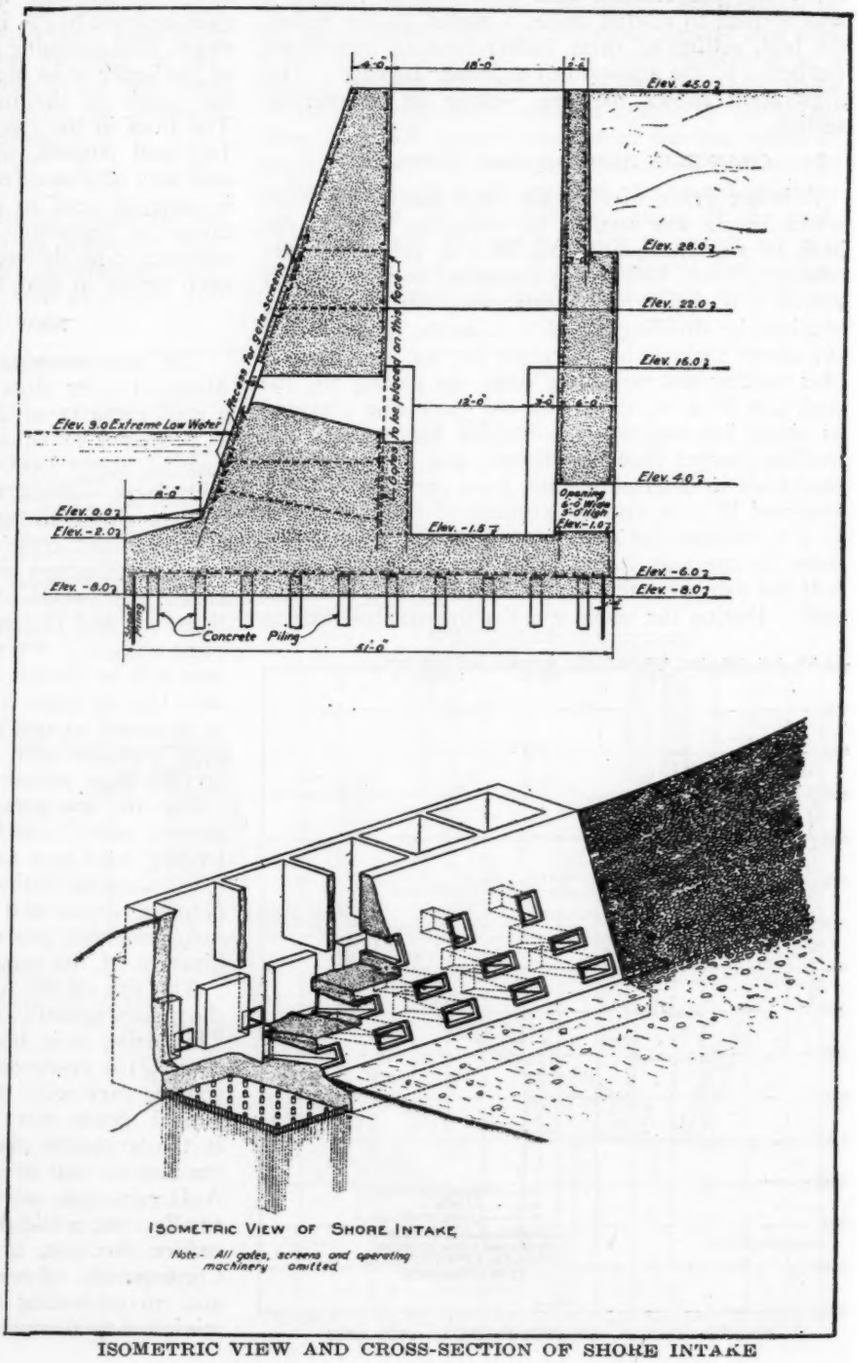
THE PROPOSED SHORE INTAKE

The new water works plant, where both pumping plant and purification plant will be located, it is proposed to locate at a bend in the Missouri river, on the concave bank of the same, thus bringing the channel close to the works, which will be located directly on the river bank. The current can be trained close to the shore by a small amount of regulation works, thus insuring deep water at a shore intake at all stages of the river, which will eliminate the possibility of ice and sand troubles such as the city now experiences annually with the intake towers in the channel. The river regulation is designed to maintain a deep channel in front of the plant at all stages of the river between the extremes of 9 feet and 43 feet. The regulation works will consist of a system of dykes extending from the north shore to within 500 feet of the south one and varying in height, allowing sufficient area for the river to pass along the south shore at all stages of the river without excessive velocity. The south bank will first be protected by short dikes and later, when the sections between these have filled to a smooth curve, this bank will be protected by revetment.

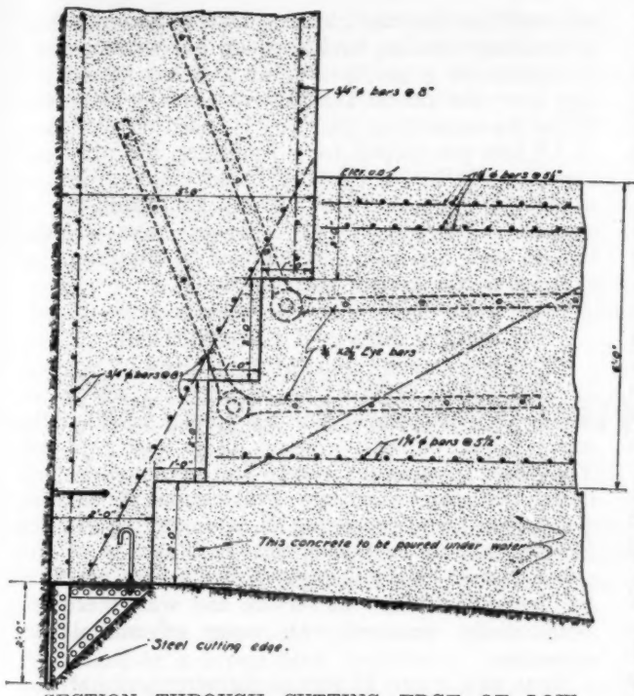
The shore intake is provided with ports arranged at three different elevations. The lower ports are rectangular, 3 feet high and 8 feet long and changing to a rectangular opening on the inside 6 feet high and 4 feet long, where suitable gates are provided. The small height of the ports on the river side gives the advantage of requiring 3 feet less depth of water than the ports of equal area in the existing intake towers, for the same submergence of the top.

It is proposed to build this intake wall in a cofferdam constructed of steel sheet piles 56 feet long. These piles will be drawn after the intake wall has been completed and each pile cut into four equal lengths and used as permanent curtain piling under the settling basin walls.

The pump pits are placed close to the intake, the low-service pit being connected to it by a separate concrete conduit for each pump. The pits will be of reinforced concrete 90 feet in diameter. It is proposed to sink them by the open caisson method, building up the sides of the pit as the caisson bottom sinks. Piles to resist both buoyancy and downward pressure are to be driven after the side walls are in place and the bottom of the pit sealed with plain concrete. On top of this a reinforced concrete bottom is to be constructed which will be attached to the side walls by means of eyebars. The general construction is shown by the accompanying illustration.



ISOMETRIC VIEW AND CROSS-SECTION OF SHORE INTAKE



SECTION THROUGH CUTTING EDGE OF LOW-SERVICE ENGINE PIT

The estimated cost of the new plant, including river regulation, buildings, purification plant, pumping plant, reservoir, mains and land, is $15,777,000.

PURIFICATION PLANT

No change was made in the purification plant or in the method of operating during the past year. A test is being made, however, to determine the best depth of sand for the filter and the best size of sand. Filter No. 19 is being used for this purpose. All the sand and gravel was removed from the filter, the strainer plates were cleaned and a gravel bed 22 inches deep was put in place. The gravel is in three layers, the bottom layer consisting of 1-inch gravel in a 5-inch layer, ¾-inch gravel in a second layer 15 inches thick, and the top layer 2 inches thick of 3/16-inch to ⅜-inch gravel. On this gravel will be placed sand of varying sizes and depths ranging from 12 inches to 24 inches. A careful analysis is being made of the results obtained with each depth of sand.

During the seven years' operation of the filters the sand has become coated to such an extent that after washing, the coating amounts to 10% of the weight of the sand. An experiment was made a short time ago of removing this coating by the use of a cement gun. The filter sand, after all the water had been drawn from it, was discharged through the cement gun against a steel plate. The sand rebounded from the plate and a great deal of the coating stuck to the plate, building up a hard bed of coating such as cement does in the normal use of the gun. Further experiments along this line are being continued.

During the year 39,540 million gallons were pumped to the purification plant by the low-service pump and 38,871 million gallons were filtered. There was added to this water 2,413 tons of sulphate of iron and 14,622 tons of lime, 2,732 tons of sulphate of alumina and 152,202 pounds of chlorine. There was removed from the water 208,459 tons of suspended matter and 12,991 tons of dissolved matter, and 27,020 tons of coagulants were precipitated; giving a total amount of matter removed of 248,470 tons.

This matter, most of which was deposited in the sedimentation basin, was flushed out through the sewer by opening mud gates about 6 inches for a half-hour period at varying intervals. Most of the deposit, however, was removed by teams at a total

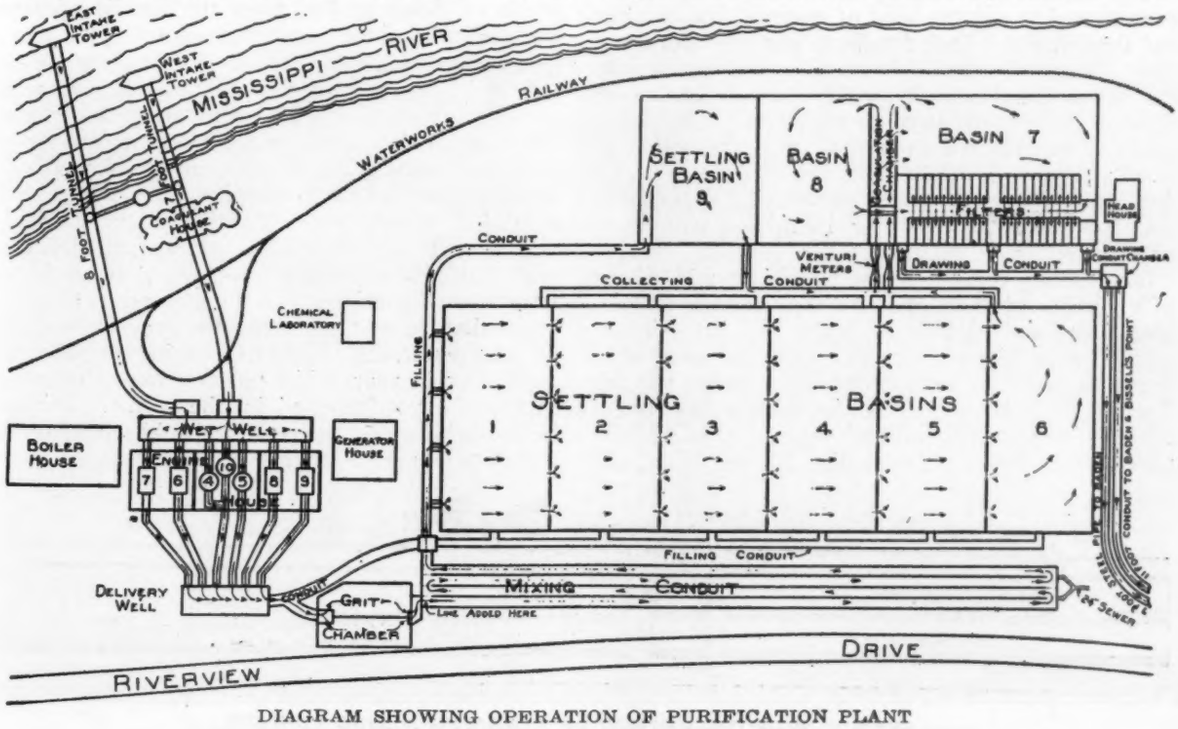


DIAGRAM SHOWING OPERATION OF PURIFICATION PLANT

cost of $9,262 for labor and teams, with a value of water used of $8,247.

After the water has passed through a grit chamber the lime is supplied at the entrance of the water into four mixing conduits, through which it passes in series, entering the western one first. These mixing conduits are rectangular in section, 7 feet wide, 11 feet deep and 2,388 feet long. They had been in service since they were constructed in 1915 without cleaning and a deposit of mud and scale had gradually formed and increased in quantity and hardness until a maximum depth of over 5½ feet was found in the west conduit, 4½ feet in the one next to it, and about 1½ feet of softer deposit in each of the others. The two western conduits were taken out of service about a year ago and cleaned. About 200 feet of the north end of the west channel was cleaned by hand, the deposit being so hard as to require a pick to loosen it for shoveling. The material was wheeled to the north end, hoisted and dumped into wagons. About 150 feet was cleaned by shoveling into a water jet discharging into a settling basin and later on the material was removed from the basin in the usual cleaning process. The remainder of the west channel and all of the adjacent channel was cleaned by flushing while a disc harrow, altered for use in the conduit, was pulled between manholes, located about 420 feet apart, by means of ropes attached to both ends of the harrow and passing over pulleys set in frames placed in the manholes at each end of the section to be cleaned. Two teams were hitched to the pulling rope and they traveled on top of the conduit in an opposite direction to the movement of the harrow in the conduit. When the harrow reached the end of the section it was turned, the ropes fastened on the opposite ends, the team turned and hitched to the rope which was the tag rope on the previous trip.

This method proved very satisfactory. The discs were turned to suit the kind of material encountered and the water was kept running about one foot deep, which swept the material loosened by the harrow into the sewer at the south end. The sections were cleaned in order from south to north. 3,250 cubic yards of material were removed, 380 cubic yards by hand at a cost of $2,199 and 2,870 cubic yards by flushing and harrowing at a cost of $1,201 for labor and approximately $124 for 10 million gallons of water used in flushing.

The mixing conduit in the new plant will consist of a number of short open conduits making 180 degree turns and capable of being run in series or parallel, to provide violent agitation of the water after lime and iron have been added for a period varying from 1 to 3 minutes; together with a few larger channels to provide gentle mixing for 20 to 40 minutes before entering the settling basins. The conduits will be open and cleaning may be accomplished by draining, flushing and scraping one section while the others are in service. This type has the advantage over the tunnel that it will save in materials. While the capacity of the latter is based on a velocity of 3.5 feet per second for 40 minutes, the proposed conduit will have a capacity based on 3.5 feet per second for 2 minutes and ½ foot per second for 40 minutes. Laboratory experiments have demonstrated that the proposed method of mixing is as effective as the one in use.

Risky Sewer Construction

The latest annual report of the Bureau of Surveys of Philadelphia tells of the failure of a sewer, the details of which cause one to wonder not that the sewer failed, but that it stood up as long as it did. The sewer in question was 13 feet in diameter, built under the tracks of the Philadelphia & Reading freight yard, and consisting of only one ring of brick headers laid up in lime mortar. A section of this sewer 85 feet long failed and placed several tracks in the freight yard out of service and was, therefore, immediately repaired with more substantial construction.

That this sewer 13 feet in diameter and only one ring of brick in thickness did not collapse before must have been due to firmness of the soil, careful shaping of the bottom of the trench to fit the invert, and a careful compacting of the back-filling at the haunches and over the arch. Even with this and with the best possible workmanship in the brick laying, it seems wonderful that this sewer stood for so many years under the constant vibration of freight trains passing over it.

Cost of Meter Maintenance

The latest annual report of the municipal water works of Reading, Pa., gives the cost of operating and maintaining the meter system during the year in question as $8,221.69. The average number of meters in service during the year was 12,678, which gives a rate of 65 cts. per meter per year. This is made up of unit costs as follows: clerical service, 23.5 cts.; reading, 18 cts.; repairing, 17.5 cts.; delivering bills, 05.3 cts.; general maintenance, 00.6 cts.

This, it seems, covers actual payments made for repairs and reading, clerical service and delivering bills and general maintenance, but nothing for interest and depreciation of the meters. The report states that the cost per meter the previous year was 37 cts. greater, due chiefly to charging off old meters as scrap that year, while not any were charged off during the year covered by the report. It would seem to be more businesslike bookkeeping to distribute the amount charged off for worn-out meters

SKETCH SHOWING METHOD OF CLEANING MIXING CONDUIT

over all years in the form of depreciation rather than to concentrate it on occasional years, which results in figures for no one year giving a correct representation of the cost of the meter service.

Metering in Cleburne

Cleburne, Texas, a town of about 12,500 people, owns its water system, which is under the control of a Board of five Commissioners. The superintendent is J. W. Hockaday, who was employed by the Board about two years ago. The town was then about 65 per cent. metered and water shortage was continually threatening. During the last two years the remaining 35 per cent. of the services were metered. In spite of this, only about one-third of the water pumper was being accounted for. After careful consideration of the situation, Mr. Hockaday received permission to make a thorough inspection of the meters. The result of this inspection and the overhauling of the meter system is that the town has plenty of water, and although the pumpage has decreased about 33 per cent. the revenue has increased by about the same percentage.

Sludge Digestion at Birmingham

By L. H. Salter.*

Four and a half million gallons per day of very strong sewage passed through sedimentation tanks and contact beds, and the sludge digested two to three weeks, producing an equivalent to Imhoff sludge.

The sewage treatment plants of Birmingham, Ala., include a septic tank installation, sedimentation tanks, sludge digestion tanks, and contact beds. These handle the sewage from about 200,000 people, three-fourths of whom are connected to the sewers. The remainder are served by one of the largest box and can privy installations in the South, the scavengings from which are dumped into the sewers.

Birmingham lies in a long, narrow valley which is drained by two main streams — Valley and Village Creeks. Paralleling these creeks are two trunk sewers, named for the creeks along which they lie. These sewers were built by Jefferson County to serve the various municipalities which since that time have been consolidated into the city of Birmingham, or now compose its suburbs. These sewers, as well as the sewage treatment plants, are under the direction of the county sanitary engineer.

The network of city sewers discharge into these county trunk sewers. Nominally, the city is sewered on the separate system, but most of the lines are actually so leaky that in times of wet weather, the sewers flow under a head, with manholes spouting like geysers. This overload clogs the county trunks and, in turn, the sewage treatment plants are loaded far beyond their capacity.

The Valley Creek sewer is 12.53 miles in length

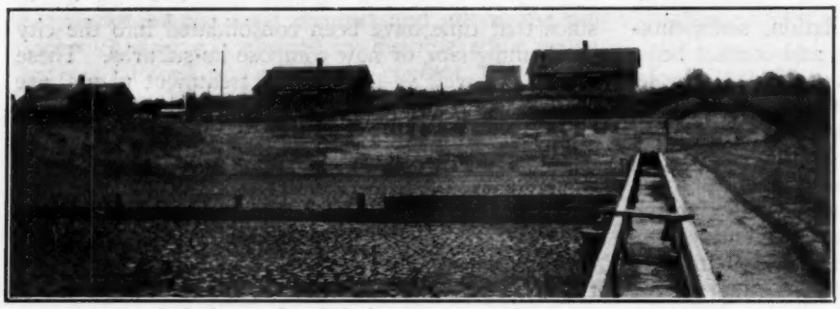
*Sanitary Engineer of Jefferson County, Alabama.

CONTACT FILTERS—SHOWING PARTS OF THREE OF THE FIVE BEDS

GENERAL VIEW OF ENSLEY SEDIMENTATION TANKS

and varies from 48 inches to 63 inches in diameter. It sewers an estimated population in Birmingham of 90,000, and in Bessemer of 10,000. The average daily flow of sewage is about 8,200,000 gallons, which is greatly increased during wet weather periods. The time of flow in the main is four to six hours, and the sewage is finely broken up, and at times becomes stale in its passage through the sewer.

The flow from the Valley Creek sewer is treated at a septic tank installation near Bessemer, known as the Bessemer Treatment Plant. This plant consists of 24 septic tanks, preceded by a screen pit and detritus tank, and followed by secondary settling tanks and strainer beds. These tanks have a depth of 13 feet, with a flat floor. The detention period is about 3 hours, with an average flow of sewage. No provision for sludge removal has been made other than to drain the tanks and remove by hand.



PARTIALLY DRIED SLUDGE ON SLUDGE BEDS
Note nearness of houses to the further bed

From the septic tanks the effluent passes to two large settling basins and then to 2.8 acres of contact beds. These contact beds have, however, been used merely as strainers since they were seriously damaged by a flood about two years ago. With the present equipment at this plant all out of date and overloaded, no repair work is contemplated.

With this treatment the effluent, of course, contains some suspended matter and is low in oxygen. Final discharge is into Valley Creek, which is heavily polluted with trade wastes, but which furnishes ample dilution. Sludge is removed about twice a year from the septic tanks, and dried on sludge beds.

THE ENSLEY TREATMENT PLANT

The Village Creek sewer varies in size from 20 to 36 inches, and is 10.4 miles long. It serves 45,000 people in Birmingham and 7,000 in the Ensley section. There are also dumped into the various sewers discharging into this trunk, the scavengings from approximately 4,500 box and can toilets weekly. This is one of the factors contributing to make strong and heavy the sewage carried by this trunk. The average daily flow is 4,500,000 gallons. An analysis of the sewage shows the following characteristics:

Total solids	982.
Suspended solids	532.
Dissolved solids	450.
Dissolved oxygen	1.0
Required oxygen	27.0
Relative stability	37.

This sewage is discharged into and treated by the Ensley treatment plant. The Ensley plant is a complete and rather unusual one. It consists of sedimentation tanks, sludge digestion tanks, and contact beds. The incoming sewage is passed through a combined screen and grit chamber, and then through a control chamber to the tanks. There are 24 sedimentation tanks, each 30 feet square, and having a maximum depth of 13.8 ft. These tanks are arranged in six ranks of four tanks each, giving a sewage flow distance of 180 feet and a retention period of 3½ to 4 hours under average flow conditions. The tank bottoms are hoppered with a slope of approximately 30 degrees, sloping into 45 degrees at the bottom. Sludge discharge is by hydrostatic head into small collecting chambers or wells, which are located in the center of each group of four tanks, whence the flow is by gravity to the pump sump.

There is no provision for reversing the flow in the tanks, so that the hoppers nearer the inlet receive the greater proportion of the settleable solids.

The tanks are operated as sedimentation tanks, and sludge is drawn from the six sludge collecting chambers at regular intervals according to schedule.

ONE END OF SLUDGE DIGESTION TANKS, SHOWING PUMP HOUSE

From the first pair of chambers serving the first 8 tanks, sludge is drawn every day; from the second set of chambers serving the third and fourth rows of tanks (the middle 8 tanks) sludge is drawn every other day; from the final pair of sludge chambers, serving the 8 final or outlet tanks, sludge is drawn every third day. The character of the sludge varies, of course, with the location of the tank, being of a much finer consistency at the outlet tank wells.

Analyses of the effluent of the sedimentation tanks show the following as an average:

Total solids	491.
Suspended solids	115.
Disolved solids	376.
Dissolved oxygen	1.4
Required oxygen	19.5
Relative stability	50.

Secondary treatment of the tank effluent is accomplished by means of 2½ acres of contact beds 5 feet deep constructed of furnace slag, 1 to 4 inches in size and placed in graded layers. Operation is by means of automatic controls furnished and installed by the Pacific Flush Tank Company. The operating schedules of the beds are with average flow:

Filling	1 hr, 50 minutes
Standing full	25 to 30 minutes
Emptying	2 hours
Standing empty	2 to 3 hours

The contact bed effluent shows the following characteristics upon analysis:

Total solids	371.
Suspended solids	50.
Dissolved solids	321.
Dissolved oxygen	1.2
Required oxygen	15.5
Relative stability	95.

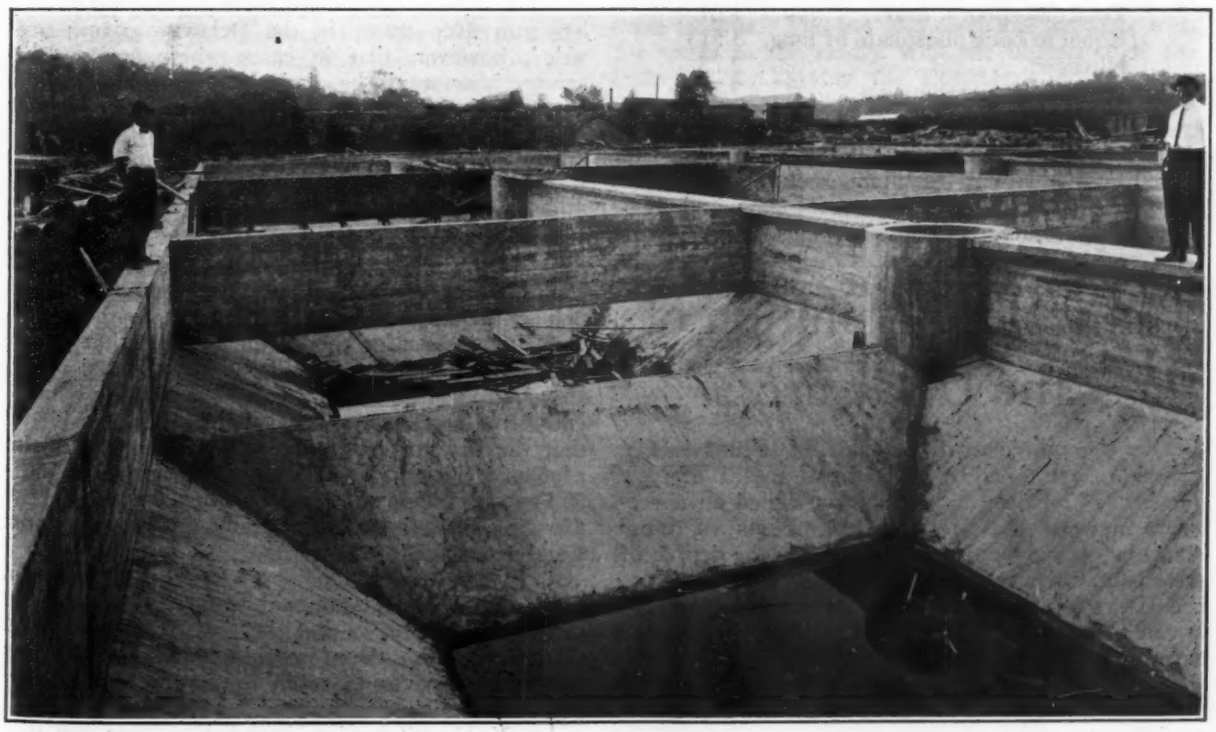
The experience with slag as a contact material has not been altogether satisfactory in Birmingham. After about 6 years of operation, the beds clogged badly. They were put out of service and the material removed and washed. In doing this it was found that there had been a slight amount of disintegration, which, with the tendency toward chinking or packing, owing to the use of various sizes of material, made too dense a bed. It is thought that the use of a single and large size—not less than 2 inches at least—of filter material would be advantageous, and this will be tried out in work planned for the near future. The use of other contact materal will also receive consideration. Contact beds must be used, owing to lack of head necessary for sprinkling filters.

SLUDGE DIGESTION TANKS

One factor inhibiting the more general use of sedimentation tanks has been the problem of sludge disposal. This has been solved in a very satisfactory manner at Birmingham by the use of sludge digestion tanks. By means of these, a sludge is secured that is comparable with Imhoff sludge, that can be handled without difficulty, that is dried on beds within a hundred feet of residences, and that seems to have some value as a fertilizer.

As already stated, the sludge is drawn from the sludge wells at intervals of one, two or three days, the sludge being entirely removed at each drawing. From the sludge wells, the flow is by gravity to the pump pit, where it is screened and pumped into the sludge tanks.

There are ten of these sludge digestion tanks, eight of which are 13.5x15 feet and two 13.5 by 20 feet. This irregularity in size is due to the fact that the tanks are built over from some old septic tanks. The extreme depth is 12.5 feet. The bottoms are



SEDIMENTATION TANKS AFTER COMPLETION BUT BEFORE USE

hoppered with an 8-inch plug valve in the bottom of each tank. The digested sludge is pumped to the sludge drying beds.

The total capacity of the tanks is about 242,000 gallons. Sludge is retained in these tanks 14 to 21 days, depending mainly upon the weather and the degree of treatment given.

In four or five days, the sludge in the tanks begins to "boil" or digest. This continues for a few days, when a heavy scum forms. This is broken up with a stream from a hose, and the action allowed to continue. About the twelfth or fourteenth day, the working or turning process ceases and the heavier parts begin to settle. A clear liquor rises to the top.

Generally the settled sludge is too stiff to handle well with a pump, so the tank contents are again mixed, or water added, and the sludge pumped to the drying beds.

It should be noted that no attempt is made to reduce the moisture content of the sludge, but that the plan is to make it easy to handle and dry. However, there is actually a considerable reduction in moisture if the supernatant liquor is not mixed back with the sludge.

The sludge as it comes from the sedimentation tanks contains approximately 95% water. After 5 days of digestion this is reduced to 88%.

The sludge beds are two in number, 120x120 and 120x110 feet. They are composed of 4 inches of sand on 12 inches of slag, underdrained by 4 inch laterals, 4 to 6 feet apart.

The sludge is usually left on the sludge drying beds 15 to 30 or more days, depending on the weather. An analysis of the dried sludge yields the following average results:

Moisture	3.12
Available phosphoric acid	1.29
Insoluble phosphoric acid	.32
Total phosphoric acid	1.61
(Equal to bone phosphate of lime.	3.51)
Nitrogen	2.23
Equivalent to ammonia	2.71
Potash	0.33

This sludge is eagerly sought for by farmers and valued by them for its fertilizing values. It is used freely for fertilizing all sorts of plants and vegetables, apparently.

Controling Pollution of the Delaware

The Commissioner of Health of Pennsylvania, Edward Martin, and the Director of Health of New Jersey, J. C. Price, in July jointly signed an agreement between the Health Departments of those states, adopting a uniform policy as to the degree of treatment to be required for sewage discharge into the Delaware river, which forms the boundary between those states. This follows several months of inspection of the river made by the engineers of the departments and conferences between them upon the subject. The agreement signed by the departments is as follows:

Uniform Policy as to Degree of Treatment of Sewage Discharge into the Delaware River.
Adopted by the Departments of Health of the States of Pennsylvania and New Jersey.

1. Sewage discharged into the Delaware river from the northern limits of the States of Pennsylvania and New Jersey to a line above the city of Easton and the town of Phillipsburg shall be treated to such an extent as to produce a clarified and oxidized effluent; and also, that so far as legally possible, the State Department of Health will prevent the discharge of untreated industrial wastes into this portion of the river.

2. Sewage discharged into the Delaware river from a line above the city of Easton and the town of Phillipsburg to a line above the borough of Morrisville and the city of Trenton shall be treated to such an extent as to effect the removal of settleable matter by means of efficient sedimentation; provided, however, that in cases where such settled sewage may be discharged into this portion of the river that it may prejudicially affect a water supply, the effluent shall be further treated to adequately safeguard the purified water supply obtained from the river; and further provided, that when plans for sewage treatment works are approved, where the sedimentation of sewage is the only treatment required under this policy, the approval shall be subject to the condition that means for the further purification of the tank effluent shall be installed when deemed necessary by the State Department of Health; and also, that so far as legally possible, the State Department of Health will restrict the discharge of untreated industrial wastes which might be a menace to public health or create a nuisance to either sight or smell.

3. Sewage discharged into the tidal portion of the Delaware river, from and including Morrisville and Trenton and to and including Philadelphia and Camden, shall be treated by means of sedimentation and the effluent discharged through submerged outlets into deep water in the Delaware river; provided, however, that in cases where such settled sewage is or would be discharged into the said tidal portion of the Delaware river at such a distance above or below a waterwork's intake that it may prejudicially affect such water supply, the effluent shall be further treated to adequately safeguard the purified water supply obtained from the river; and further provided, that when plans for sewage treatment works are approved, where sendimentation of sewage is the only treatment required under this policy, the approval shall be subject to the condition that means for the further purification of the tank effluent shall be installed when deemed necessary by the State Department of Health.

3-A. From data now available it is considered that the discharge of only settled sewage into the aforesaid tidal portion of the Delaware river within two miles of a water work's intake of an efficient filtration plant may prejudicially affect such water supply.

4. In case the said point of sewage discharge is from one state and the said waterwork's intake is in the other state, so that the sewage effluent while discharged within the aforesaid two miles would have to cross the river to reach the water intake, then before a decision is reached by the State Department of Health having jurisdiction over the dis-

charge of sewage, the case shall be taken up with the other State Department of Health for a careful determination of the probability of the discharge of only settled sewage prejudicially affecting the water supply.

This agreement was signed on July 7 by Edward Martin, Commissioner of Health, for the Department of Health of Pennsylvania; and on July 13 by J. C. Price, Director of Health, for the Department of Health of New Jersey.

Disposal of Activated Sludge

By R. H. Eagles *

The use of sulphur dioxide gas has been tested at Houston, Indianapolis and Gastonia and appears to produce an ionic condition favorable to dewatering, prevent putrefaction and increase the ammonia content.

So many unsuccessful efforts have been made in the past few years to develop a commercially applicable method of dewatering activated sludge, that any new method which is advanced is met with a decided skepticism. The fact remains, however, that numerous small-scale and semi-commercial experiments have actually produced a dried product in suitable condition for use as a fertilizer. Furthermore, it has been definitely shown that this dried product has a considerable agricultural value, and can doubtless find a ready market demand if produced with some uniformity and in sufficient quantity at any given plant.

The extent of the marketability, the relative commercial fertilizer value, and the cost of continuous production, have not yet been determined largely because no dewatering process has been able to operate uniformly for a sufficient period to supply reliable data on operating costs. There is every indication, however, that a reasonably economical dewatering process, satisfactory in other respects, will result in sufficient revenue to defray the cost of sludge disposal, and in some cases yield a profit to be applied against the operating expense of the aeration plant. In either event, successful sludge disposal will tend toward the more general adoption of the activated sludge process by inland cities, since it will result in a net operating cost more comparable with other treatment methods producing a similar purity of effluent.

The dewatering of raw activated sludge has been attempted with so many different types of apparatus, without any uniformity of results, that more recent efforts have been confined largely to the use of pretreatment or conditioning methods to convert it into physical condition more adaptable to dewatering by ordinary methods and equipment.

There are two chief factors governing the favorable physical condition of activated sludge for dewatering. The first is the ionic condition of the liquor, which should be so controlled as to yield a more or less porous or granular solid from which the excess water can find easy egress, when the sludge is pressed or drained. The second factor is the biologic condition of the solids. If activated sludge is allowed to become septic, or partially so, a decay will set in which leaves the sludge structure fragile, and any attempt to handle it will result in disintegration with the formation of finely divided solids which are difficult to dewater.

It is well known that fresh, well-aerated sludge is more amenable to dewatering than stale or partially septic sludge. In practise, however, it is difficult to control this condition with any uniformity. The remedy suggests itself to sterilize, or partially sterilize the sludge immediately after withdrawal from the settling basins, to yield a "bacterially stable" sludge—that is, one which will not decompose during the dewatering period.

Sulphuric acid has been found beneficial as a conditioning agent to produce the proper ionic effect, but it has only a slight sterilizing effect, due to the low concentration used, and the difficulties of securing a quick and thorough mixing with the sludge. Furthermore, the use of acid has not been found entirely satisfactory by reason of the close control required, excessive cost, difficulties in storage and handling, and corroding effect on equipment.

To secure the beneficial effects of sulphuric acid without the expense and other disadvantages, and in addition to secure a sterilizing effect, a process has been developed that utilizes sulphur dioxide gas, produced by the burning of crude sulphur as required. This is known as the Maclachlan process. Sulphur dioxide is a well-known germicide, and its action on activated sludge is to arrest putrefaction for a considerable period. Well treated samples have remained fresh and odorless for as long as three months. The gas also combines instantly with the water in the sludge with the liberation of the hydrogen ion, giving the electrolytic effect which produces a porous and granular sludge solid.

The advantages of the sulphur dioxide treatment are low cost, simplicity of application, and ease of control. Crude sulphur costs from $15 to $20 per ton delivered, and approximately 75 lbs. will treat the activated sludge from one million gallons of sewage. The economy over sulphuric acid will be obvious when it is considered that the burning of crude sulphur is frequently the first step in the manufacture of sulphuric acid, and to this must be added the other manufacturing costs plus the expense of shipment.

The simplicity of application lies in the fact that a gas does its own mixing by agitation. A treating tank has been designed which accomplishes thorough absorption of the sulphur dioxide, and enables a continuous treatment of the sludge at a high rate of flow.

The ease of control is due to a peculiar color change taking place, which is easily observed by even an unskilled operator. A well treated sludge is golden brown in color, while under-treated is dark brown to gray. An excessive treatment does no harm, within reasonable limits, and is practically impossible with properly designed units.

* Sanitary engineer, Maclachlan Reduction Process Co., Inc.

For best effects, the gas treatment is applied to the sludge immediately after its removal from the settling basins. Septic sludge is sterilized equally well, but the colloidal action will have progressed too far, as a rule, to yield a product amenable to dewatering. Fresh sludge after gas treatment should be promptly dewatered since the ionizing action is more or less temporary, as in the case of acid treatment. However, gas treated sludge has been held over for more than twenty-four hours, still maintaining its dewatering properties, probably due largely to the absence of bacterial decomposition.

From a fertilizer standpoint, the application of the sulphur-dioxide treatment is highly beneficial, since it prevents the loss of ammonia through bacterial decomposition and volatilization in the dryer. It also actually enriches the ammonia content of the finished product by dissolving a portion of the alkaline earth metals present in the sludge, passing them off in the effluent. Sulphuric acid, on the other hand, tends to throw out precipitated sulphates which appear in the final product as a solid diluent, thereby lowering the percentage of ammonia. This fact is rather clearly indicated in the last column of the following tabulation which shows comparative averages of a series of filter press experiments at Houston on raw sludge, acid treated and sulphur dioxide gas treated. It will be noted that the ammonia content after gas treatment is 1.5% higher than after the acid treatment, an increase of 31%. 976 lbs. of acid per ton of sludge solids was used in the latter. Assuming the same gross amount of ammonia is retained in both treatments, the percentage of ammonia in the final product would be 2.1% lower in the acid-treated product if all the acid added remained with the sludge solids. This checks fairly closely, allowing for some of the acid to go off in solution, as must actually be the case.

Comparative Tabulation of Filter Pressing Experiments at the Houston, Texas, Activated Sludge Plant

	Moisture in feed to presses.	Moisture in press cake.....	Time to press one charge.....	Dryer evap. ratio	Ammonia content of dried sludge.
Raw sludge.....	98.6%	87.3%	4 hr. 40′	8.9	3.6%
Acid treated.....	98.6	82.7	3 hr. 33′	5.7	4.8
Sulphur dioxide gas treated....	98.9	78.7	3 hr. 19′	6.5	6.3

From a sanitary standpoint, the deodorizing properties of the sulphur dioxide treatment make the process a valuable addition to any activated sludge plant. One of the arguments advanced in favor of the latter is the freedom from operating nuisances around the plant. Surplus sludge is liable to accumulate around the plant at times, and it rapidly becomes septic and malodorous, particularly in warm weather. If all sludge is treated with sulphur dioxide immediately after withdrawal from the settling basins, it will remain odorless for a long period, and will not attract flies or vermin.

Careful study of the sulphur dioxide treatment at activated sludge plants located at Houston, Texas; Indianapolis, Ind., and Gastonia, North Carolina, has fully demonstrated its efficiency and economy as a conditioning treatment to put the sludge into shape for final dewatering. This is a highly important phase of the entire activated sludge problem, and its successful accomplishment marks a big advance in the art. Of equal importance, however, is the development of suitable equipment for completing the dewatering.

The filter press and the centrifuge, with various modifications, have received most of the attention thus far, although some attempts have been made at drying on sludge beds. The filter-press entails a high operating cost through labor requirements and cloth maintenance, and great difficulty has been experienced in producing a firm, dry cake with any uniformity. The centrifuge has been found to effect a low recovery of solids, and has not succeeded in turning out a very dry cake. It is also expensive to operate. Both of these machines are open to further objection, and cannot be said to be very attractive to the sewage plant operator.

Attention is now being directed toward the development of a new device, different in principle from both filter press and centrifuge, which will economically produce a solid cake suitable for final drying. The sulphur dioxide treatment has been found to produce an entirely different character of sludge structure which can be handled by simpler methods than heretofore possible. The objective is to develop a fool-proof machine which can be relied upon to operate with uniformity, and at a cost which will enable the entire dewatering operation to show a profit.

The final drying of the sludge has not received much attention to date, for the reason that there has been a scarcity of sludge produced in proper shape for drying. Such tests as have been made have brought forth no unusual difficulties, and it is reasonable to assume that most of the commercial types of dryers for organic materials, either direct or indirect, will answer the purpose. If the sludge cake can be produced dry enough, it is probable that air drying will be found feasible in many localities, particularly at the smaller plants.

To sum up, it is safe to predict that the rapid strides which have been made toward successful sludge dehydration in the past year will lead to an early solution of the entire problem. With this accomplished, the activated sludge process will find more favorable consideration from engineers in charge of new sewage treatment projects. The more general adoption of this process with the utilization of the sludge as a fertilizer will go far towards eliminating a considerable economic waste. The greater part of the fertilizer ingredients taken from the soil find their way eventually to human consumption and are eliminated in the two great forms of municipal waste—sewage and garbage. The successful reduction of municipal garbage for the production of a fertilizer material, and grease, has come through a difficult development period to a point here it is being handled at a profit in many cities. When the sewage loss is also eliminated through the perfection of the activated sludge process, we may expect to eventually achieve a fairly complete "fertilizer cycle," with the ensuing benefit to mankind.

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Sludge Digestion Tanks

In this issue we describe what are probably the two largest sludge digestion plants in the country, those at Baltimore and Birmingham. In Baltimore the combination of sedimentation tank and sludge digestion tank has partly supplanted Imhoff tanks and the plans now under way contemplate the complete change of the Back River plant of Baltimore to this type of treatment. Birmingham years ago built a septic tank plant, but its latest developments have been towards the same type of treatment as Baltimore's, with the probability of future abandonment of the septic tank. A few other communities have adopted sludge digestion tanks, but so far as we know not more than twelve installations of these are to be found in service in the United States.

We have given considerable space to this method of treatment in this issue because it seems to us that the tendency during the next few years will be towards this as a substitute for the Imhoff tank, which has been the popular favorite during the past ten years or so. The advantages claimed for the sludge digestion tank are given at some length by Mr. Keefer in his description of the Baltimore tanks. In general the claim is that both the sludge and the effluent obtained by plain sedimentation and sludge digestion are equally as good as from the Imhoff tank, while the cost of construction is considerably less and both the cost and trouble of operation are less.

Apparently considerable remains to be learned concerning the operation of sludge digestion tanks and the best method of constructing them. For instance, in the Baltimore plant, two sets of tanks acted in directly opposite manners, digested sludge rising to the surface in one set and falling to the bottom in the other. Even with the present limited information, however, the results obtained would seem to be sufficiently encouraging to warrant more general adoption of this system, and certainly would seem to offer the greatest inducement for a further study of this type of sewage treatment appliance.

Tight Joints in Sewer Pipes

Years ago sewer pipes were laid in England with clay as jointing material. These joints, of course, were not or did not remain tight, but they were cheap. Because of its unreliability, no American engineers now consider using clay, but cement mortar is considered standard, even though the expense is greater.

In wet trenches, however, cement mortar joints made in the ordinary way seldom produce tight sewers. Moreover, unless the inspector is keenly on his job, the bottom of the joint is very likely to be neglected, even in a dry trench. The result is that cement mortar joints are seldom perfectly tight and frequently not even approximately so. It would seem that the time had come to make another step forward in the matter of sewer joints and secure joints that are really tight. The cost will probably be a little greater, as was that of the advance from clay to cement, but the step is desirable for sanitary reasons and may even prove economical, all things considered. For instance, leaky joints may admit so much ground water as to require doubling or treb-

ling the capacity of a sewage treatment or pumping plant.

The undesirability of admitting ground water through the sewer joints is now generally recognized, but there is another very urgent reason for tight joints where there is no ground water. This is to prevent the entrance of tree roots into the joints. Where moisture escapes from a sewer into dry ground, if there are poplars, elms or in fact almost any trees, in the vicinity their roots are likely to find the sources of moisture and, entering the joint, produce in the sewer masses of roots that will partially and sometimes entirely clog it. If there is no leakage from the sewer to moisten the ground, this will not happen no matter how near the trees may be.

Cities are spending from $4,000 to $30,000 a mile for pipe sewers. There are methods of obtaining tight joints throughout the entire sewer system which probably would not add more than $100 to $200 a mile to the cost. Where there is ground water there can be no question of the economy of making this additional expenditure, and the same is true where trouble from tree roots is anticipated. Taking into account that there are other reasons, such as avoiding pollution of the ground, or the saturating of the ground so as to permit settlement of the sewer and consequent deposits of sewage in the low points therein, we believe that engineers will do well to consider seriously whether it would not be advisable to adopt as standard practice some method which will insure reasonable tightness of sewer joints throughout the system.

Recent Sewerage Work

The recovery of highway work from the effects of the war has, it is generally recognized, been more rapid and complete than that of almost any other kind of public work. A certain amount of extensions and renewals of water works plants and distribution systems has been found necessary also, and much of it has already been performed or at least begun.

Apparently sewer work has not been considered so important, and it has been deferred still longer, probably waiting for lower prices or other more favorable conditions. This is indicated by the data which we have collected during the past month and which are published in this issue. Out of more than 1,500 cities, towns and villages of all sizes that have received our questionnaire, only about 260 have reported any sewerage work done during 1922 or 1921. A number of the communities did not reply to the questionnaire, and there is reason for thinking that in the majority of cases this was because there was no work to report. If we consider only those that reported in one way or another, we find that 100 of these took the trouble to inform us that no work had been done by them during the past two years. Moreover, the amounts done by those that did report are seen, in the majority of cases, to have been comparatively small.

While this showing for the past two years is a poor one, it is probable that the amount of work to be done in the future must necessarily be all the greater therefor. Our communities are not going to fall permanently behind in the essentials of civilization, although they may at times lag, and the collection, removal and disposal of sewage wastes is recognized as one of the essentials of modern civilization.

While the construction of sewage is taken for granted as an essential municipal work, sewage disposal plants have not yet been recognized as a common appurtenance of a sewerage system and probably very few realize how common they are becoming. We have in this office a list of about 2,500 sewage treatment plants, more than 1,600 of which are municipal plants. A great majority of these have been built during the past fifteen years, but comparatively few during the war, so that the average rate before then was probably in the neighborhood of 200 plants per year. Construction of treatment plants will soon be renewed and probably will continue until all existing systems where they are necessary have been supplied.

In later issues we will give some general summaries and details of the information which we have on this subject.

Sewage Effluents and Water Supplies

One of the problems being studied by the Federal sanitary engineers is the relative effects of sewage effluents of different degrees of impurity upon water filtration plants having intakes at different distances from discharge points of such effluents. In other words, given an effluent of a certain degree of strength as to both organic and bacterial content, and a certain degree of dilution of such effluent, how far must it be discharged from a water works intake if a filter plant is to handle safely the water obtained from the river at such intake; or, given the intake for a water filtration plant and a sewer outlet located a certain distance apart, what degree of purification must be secured in treating the sewage to avoid overloading the water filtration plant?

As stated elsewhere in this issue, the State Health Boards of New Jersey and Pennsylvania have adopted a uniform policy as to the polution that each will permit the cities of its state to discharge into the Delaware river. This agreement divides the river into three sections or lengths, one above the city of Easton, a second between Easton and Trenton, and the third known as the tidal portion below Trenton. Sewage discharged into the first of these stretches of river, which forms the attraction for many vacation resorts, must be so treated as to produce a clarified and oxidized effluent; that discharged into the middle stretch must have been so treated as to be freed of settleable matter; while in the tidal portion, sewage shall be treated by sedimentation and the effluent discharged through submerged outlets into deep water.

As to this third section there is a further provision that "where such settled sewage is or would be discharged into the said tidal portion of the Delaware river at such a distance above or below a water works intake that it may prejudicially affect such water supply, the effluent shall be further treated to adequately safeguard the purified water supply obtained from the river." For several months engineers of the two states have been acting together in making a study of the river and from the data available the health departments believe that if sewage which has been treated only by passage through a sedimentation tank is discharged two miles or more

from the intake of a water works plant, such effluent will not prejudicially affect the water supply. This distance applies when sewage outlet and water works intake are on the same side of the river. Where they are on opposite sides it is thought probable that, in some cases at least, this distance could be lessened, but no definite rule is stated and each case has to be considered on its own merits by a joint investigation made by the two departments.

Several years ago the engineers of the Federal government began an exhaustive study of this question in the Ohio river, but unfortunately the war interfered with the study before it was completed, and the result of the investigation has never been published, although preliminary conclusions therefrom were given out by one of the engineers. Other similar investigations are being carried on and information on the point referred to is being accumulated which will aid sanitary engineers greatly in reaching conclusions concerning this relation of stream pollution to the loading of water works filters. The problem is by no means a simple one, involving as it does the effect of volume and velocity of stream flow upon sedimentation, intermingling, oxidation through absortion of oxygen from the air, the action of animal and vegetable life in the river upon organic sewage matters, the element of time as it affects all of these, and other affecting agencies some of which are known and some of which are undoubtedly unknown as yet.

Weather, Strikes and Highway Programs

In spite of the fact that prices were fairly high, there was every indication that 1922 would be a record breaker in highway construction. It only needed the final passing of the bill renewing the appropriation of federal aid to confirm the states in their resolve to construct as much highway mileage as the supply of material and availability of efficient contractors would permit. However, as has happened in previous years, conditions have interfered to curtail the road building program. The railroad and coal strike, the first operating directly as well as indirectly and the latter indirectly, have already had some effect upon the ability of highway authorities and contractors to obtain materials for carrying out their road building programs and it seems extremely probable that within a few days, or weeks at the outside, the rail transportation of most road building materials will be entirely stopped, as open-top cars will be used exclusively for the hauling of coal as soon as coal becomes available in quantities at the mines. This condition affects the entire country.

In the east there has been another condition, that of the weather, which has seriously interfered with road construction. Over a considerable part of the Middle Atlantic states, and to a somewhat less extent to the north and south of them, rainfall has been so almost continuous for the past two or three months as to interfere seriously with road construction, keeping the subgrade continuously wet and soggy, so as to interfere with the proper placing of the paving material even when the actual rainfall did not prevent working upon it. As a consequence of this weather condition, road improvements in this section of the country have fallen considerably behind, but it was hoped that with the cessation of wet weather the total construction for the season might still be carried to record figures. However, the rain has not stopped falling as yet and, as already stated, there seems to be absolutely no escape from the conclusion that the transporation of highway materials will be seriously interfered with by the withdrawing of open top cars from that service if the coal strike is settled, or, if this strike is not settled, by the withdrawing of them from any service because of the railroad strike.

Trucks Versus Highways

The competition between the inventors and makers of armor-piercing projectiles and those who in turn produce armor which they cannot pierce, but which in turn is pierced by projectiles of later development, seems to have its parallel in the manufacturers of trucks and roads respectively. When five-ton trucks were found to be too heavy for certain classes of highways, heavier highways were built to meet this increased demand; but before even a large percentage of them had been so reconstructed the truck manufacturers were turning out ten-ton trucks and expecting the states and counties to provide highways that could carry *them*. There is no reason for thinking that trucks cannot be made to capacities of 20, 30 or even 50 tons if such capacities promise to be economical for transportation and the highway pavements can be made sufficiently strong to carry them.

The same thing but to a much less degree has been taking place in the railroad world, where locomotives have been increasing in weight and power and the rails to carry them have been necessarily made heavier and more strong and durable. In the latter case, however, the progression has been entirely in the control of one party and the increase in either locomotive or rail has been governed by careful calculation as to the ultimate economy, taking both into consideration. In the case of the truck and the highway, however, the cost of constructing and maintaining the highway is no concern of the truck manufacturer or user, since none of the cost comes out of his pocket, but all is paid either by the taxpayers directly or by traffic in general. There can be no question that the point will be reached, if it has not already been reached, when further increase in weight of truck and consequent cost of highway will cease to be economical, if all expenditures and profits are taken into consideration, and some authority should be given the power to limit the weight of truck, or else the truck users must be put in the position of paying such share of the cost of the highway as to cause them themselves to feel and heed the economical limit.

It has been said a number of times and by a number of those interested in the problem that highways should be made for the traffic and that, no matter what the traffic demands may be, the highways must meet those demands if it would not halt the progress of civilization. We do not believe that the taxpayers of the country will accept this dictum if the facts and logic are placed fairly and squarely before them.

Most of the attempts at solving the problem so far have been in the form of state limitations to the weight of trucks that will be permitted to use the highways of the state in question. Maryland is an illustration, and her limitation of the weight of trucks is explained and defended in an article published elsewhere in this issue by J. M. Mackall, chairman and chief engineer of the State Roads Commission.

One method of requiring trucks as well as other vehicles to pay in proportion to the use they make of the roads is by the gasoline tax, which has become quite popular within the past year or two, having been adopted in Arizona, Arkansas, Colorado, Connecticut, Georgia, Kentucky, Louisiana, Maryland, Mississippi, Montana, New Mexico, North Carolina, Oregon, Pennsylvania, South Carolina, South Dakota, and Washington. The Chief of the Bureau of Public Roads, in urging that sources of revenue for highways be adopted that would be paid by road users, states that $40,000,000 annually could be raised for road building and maintenance by a tax of one cent per gallon of gasoline.

Another method of bringing the economic limit home to the truck user is offered by Colorado. The Colorado Public Utilities Commission holds that truck owners have no right to make profit out of capital furnished by the taxpayers in the form of public highways. The Commission has recently handed down a decision denying motor trucks the right to use certain roads because they do not contribute their share towards the construction and maintenance of such highways, comparing them with the railroads, which pay much larger taxes and yet construct and maintain their roadbeds at no cost to the public.

This Colorado decision was made in passing upon transportation conditions in Eagle and Garfield counties, there being 68 motor trucks operating as public carriers that passed through these counties on their regular route, but which paid into the state treasury only $918 per year for the use of state and county highways. This was not only unfavorable to the counties, but it was shown to be unfair to a competitor of the truck lines, the Denver & Rio Grand Western Railroad, which paid $38,023 into the fund for public roads, which they do not use at all, and in general paid other taxes which made their total contribution to these two counties $153,869. The following paragraph is contained in the opinion of the Colorado Commission:

> Public convenience and necessity, by which must be understood the convenience and necessity of the people at large as contradistinguished from the convenience and necessity of a very small number of people who seek to derive a profit from the farmers' and homeowners' investment in roads, never contemplating that the truck driver should destroy that, to the cost of construction of which he contributed little or nothing, or that he should reap where he has not sown. When the taxing laws of this State are so amended that the truck driver operating over State highways shall contribute his due proportion to the cost of construction and maintenance of our highways, then, and only then, can this Commission regard his use, under proper conditions and restrictions, of a great tremendously expensive public facility of equal dignity and equal benefit to the people with moderate use thereof by the ordinary taxpayer.

Radio in Highway Work

State Highway Commissioner Frank Page of North Carolina has arranged to have installed in his office in Raleigh a radio broadcasting station, while receiving stations will be placed in each of the nine district offices. In this way the administrative force of the Commissioner will be able to get into immediate touch with the construction and maintenance engineers throughout the state and thus effect a saving of several hundred dollars a month in telegraph tolls and stenographers' services.

It is believed that no other state is using radio for this purpose. The equipment is part of the surplus war material which is being distributed and was offered to Commissioner Page and immediately accepted by him. Thus the equipment will be secured without cost to the state except that of installation. It was expected that stations would be in service by the middle of August.

Cement Production and the Coal Shortage

The Portland Cement Association calls attention to the fact that the cement industry, being the fourth largest consumer of coal in the country (over 7,000,000 tons being consumed by cement mills every year), is being seriously affected by the coal shortage. Many of the plants have to secure their coal from more distant mines than ordinarily, which increase the cost, which increase is likely to be reflected in the cost of cement. In fact, unless the strike is settled very soon many of the plants will have to shut down.

The industry is affected also by the railroad strike. The equivalent of 377,000 box cars of 50 tons capacity each were required to haul last year's cement output. Also, 3,000,000 sacks are used every year for shipping the cement and the textile strike is likely to cut down the supply of sacks.

Cost of Road Rollers

In a letting on July 19 by the State Highway Department of Kentucky, bids were received for a 10-ton roller with scarifier from nine firms. The bids ranged from $4,000 to $5,100 for a steam-driven roller, and from $3,045 to $5,490 for one motor-driven. One firm offered $450 credit for an old war equipment roller.

Study of Tractive Resistance on Roads

A bulletin of the Federated American Engineering Societies announces that initial results from an investigation of the tractive resistance of roads indicates that information will be secured of great value to the highway engineers, and users of motor transportation. The investigations are being carried on under the auspices of the recently created Advisory Board on Highway Research of the National Research Council with which the Bureau of Public Roads and Quartermasters Corps are co-operating. Dr. Hatt, who is on leave from Purdue University, is directing the work.

Street and Sewer Work in Cincinnati

Figures for 1921 showing cost of cleaning streets and catch basins by machinery and comparison with hand work.

The year 1920 saw some radical changes made by the Department of Street, Sewer and Catch Basin Cleaning of Cincinnati, chiefly from hand to machine methods of cleaning streets and catch basins. During this year auto flushers, auto sweepers, and auto eductors were introduced. Referring to this in his annual report, the superintendent of the department, Fred Maag, stated that the motorization of the various street cleaning apparatus served to decrease the size of the working forces and aided in meeting the problem of restricted appropriations. "The auto flushers have rendered wonderful service. Having a carrying capacity of three times the old horse-drawn flusher and with the use of centrifugal pumps, they can outwork the old style flusher many times, both in quantity and quality of work. Our statistics will show in comparison quite a saving in unit costs between the two types and methods of flushing." The figures referred to show in brief that the horse flushing done last year cost 12.4 cents per square or 26.2 cents including overhead (the word "square" is used in Cincinnati to designate an area of 16,000 square feet), while the auto flushers operated at a cost of 2.2 cents or 5.0 cents including overhead.

"Our auto sweepers and pick-up machines have given a good account of themselves, being particularly adapted to improved streets. The auto eductors or sewer basin cleaners have proved themselves worthy in every respect. The savings made through our motor street and sewer cleaning apparatus has justified the investment of the large sum necessary for their purchase. It will be only a short time until the savings made will approximate the purchase price paid for this equipment."

The unit costs for the various forms of street cleaning other than flushing during 1921 are given as follows: street sweeping, 50.2 cents per cubic yard or 89.4 cents including overhead. White wings, 43.4 cents per 1,000 square yards or 49.6 cents with overhead. (Equals $6.99 and $7.936, respectively, per square.) Broom gang, 32.5 cents per square or 37.7 cents with overhead. Gutters, 25.0 cents per square or 27.9 cents with overhead. Gutters after flushing, 25.2 cents per square or 28.1 cents with overhead. (For gutters, a square is taken as 400 lineal feet—probably the average distance between intersecting streets.)

In the details of costs of horse and auto flushing, we find that the total number of horse-days for the year with the horse flushers was 1,069, giving an average cost per square flushed of 12.4 cents, while the total overhead cost was $2,685, or 13.4 cents per square. The auto flushers went into service in May and the labor cost with them averaged 2.2 cents per square, while the overhead, which totaled $3,347 averaged 2.8 cents per square. It will be noted that in each case the overhead cost was greater than the labor cost.

With hand labor such as white wings and gutter cleaning, the overhead is naturally comparatively small. The cost per 1,000 square yards for white wing labor averaged 43.4 cents, and the overhead only 6.2 cents. For gutter cleaning, the average cost for labor was 25 cents and the overhead averaged 2.9 cents.

Catch basins were cleaned by both hand and auto eductor throughout the year, the latter having removed 3,239 cubic yards from 2,335 basins, while 4,050 cubic yards were removed by hand from 1,264 basins. The labor per basin cleaned is given as $5.-507 by hand cleaning and $.979 by auto eductor, or $9.032 and $1.660, respectively, including overhead. Using the cubic yards removed as the basis, the unit costs for labor were $1.719 for hand cleaning and $0.705 for auto eductor cleaning, and for overhead were $1.100 and $0.491, respectively.

In comparing the cost of street cleaning in different cities it is not uncommonly difficult, if not impossible, to determine just what is included in each item of cleaning. For instance, does "hand sweeping" include the entire cleaning of the street without aid from sweeping machines or flushers, or is it supplementary to these? In other words, what is the total cost per unit of area or street length of keeping the street clean, including all of the processes and equipment used on this particular stretch of street? In Mr. Maag's report he has grouped together the various processes that operate together for cleaning a given area and the results are shown in the accom-

Cost of Labor and Overhead, per Square of 16,000 Square Feet, or 400 Lineal Feet, for the Years Ending December 31, 1920 and 1921

Operation	1920 Labor Unit	1920 Unit with O'rhead	1920 No. of Squares Cleaned	1921 Labor Unit	1921 Unit with O'rhead	1921 No. of Squares Cleaned
Total cost of flushing	$ .151	$ .325	.....	$ .022	$ .050	.....
Gutters after flushing	.194	.216	14,008	.252	.281	49,361
Removal of dirt	.169	.311	.....	.152	.272	.....
Total cost of cleaning, per sq	.514	.852	.....	.426	.603	.....
Gutters	.258	.288	50,562	.250	.279	46,304
Removal of dirt	.169	.311	.....	.152	.272	.....
Total cost of cleaning, per sq	.427	.599	.....	.402	.551	.....
Broom gang	.320	.368	88,223	.325	.377	104,351
Removal of dirt	.169	.311	.....	.152	.272	.....
Total cost of cleaning, per sq	.489	.679	.....	.477	.649	.....
White Wings	.728	.835	53,502	.772	.882	53,040
Removal of dirt	.169	.311	.....	.152	.272	.....
Flushing	.151	.325	.....	.022	.050	.....
Total cost of cleaning, per sq	1.048	1.471	.....	.946	1.204	.....
Total number of squares cleaned	.....	.....	206,295	.....	.....	253,056
Cu. Yd. of dirt per square	.....	.....	.365	.....	.....	.304

panying table. It would be a great aid to a comparison of these costs with costs in other cities if other superintendents would similarly combine those items of street cleaning operation that are employed co-operatively on given areas.

In the table it is noted that the total cost of cleaning streets where flushing is employed, including overhead, was 60.3 cents last year, of which the flushing itself was only 5 cents. Cleaning a street by broom gang, including removal of dirt, cost 64.9 cents per square or about 7 per cent. more than cleaning by flushing. Considering only the cost of the sweeping in one case, however, and the flushing in the other, we find that the former cost 7-1/2 times as much as the latter.

In the case of cleaning with white wings, the items of flushing and of removing dirt are charged at the same rate per square as in the other combinations, and in addition the cost of the white wings is given as 88.2 cents. The cost is increased over that of flushing alone by the difference between the cost of the white wings and the cost of sweeping up the dirt in the gutters after the flusher has passed, which is 60 cents a square.

Comparing the costs in 1921 with those in 1920, we find in the case of flushing a reduction of about 9 cents in the labor in 1921, but a reduction of 16 cents in the overhead. This probably is due chiefly to the fact that the number of squares cleaned was 3-1/2 times as great in 1921 as in 1920, thus distributing the overhead over a considerably larger area. This seemed probable because in the other cases the reduction in overhead is approximately the same as that in labor.

Mr. Maag makes a comparison of the labor cost of horse-drawn flushers and auto flushing, the latter of which was begun in May, 1921, which shows that the horse-drawn flushing cost for labor alone 12.4 cents per square, while auto flushing cost but 2.2 cents; or, including overhead, the cost was 26.2 and 5.0, respectively.

Resurfacing Old Pavements*

Methods reported by city engineers for renewing or covering worn wearing surfaces of concrete, macadam and other kinds of pavements.

CONCRETE PAVEMENTS

Richmond, Cal., uses paint coat of asphalt covered with screenings for resurfacing old concrete pavements.

Boulder, Colo., resurfaces with asphalt on concrete alleys.

Washington, D. C., has resurfaced a few concrete roadways with about 2 inches of sheet asphalt.

Chicago, Ill., in resurfacing concrete cleans the surface and paints it with A. C., and places 1½ inches of binder and 1½ inches of asphalt top, or 2 inches of asphaltic concrete in two courses, using penetration 38 to 60, depending upon the traffic conditions.

Chicago Heights and Freeport, Ill., resurface concrete with sheet asphalt, using standard specifications.

Des Moines, Ia., in repairing old concrete cleans out cracks and holes, paints the edges with Tarvia B, fills the cracks with mastic of Tarvia XC with coarse sand and gravel; sprinkling a thin layer of coarse sand over the top. Deep holes and depressions are cleaned out and hot Tarvia B brushed on and the hole filled with broken rock or granite. Hot Tarvia X is then applied with sufficient gravel to fill the interstices. More hot tar is applied and the surface is covered with coarse sand and gravel. "These patches hold very well and make a fairly acceptable surface."

Ottawa, Kan., resurfaces concrete with sheet asphalt.

In Baltimore, Md., concrete has been given a flush coat of Tarvia A applied hot at the rate of 0.6 gallon per square yard, then covered with gravel passing a ¾-inch ring at the rate of 70 pounds per square yard.

Owasso, Mich., resurfaces old concrete with 1½-inch binder and 1½-inch asphalt top.

Webster Grove, Mo., covers concrete with a light treatment of tar and pea sized gravel.

Kansas City, Mo., thoroughly cleans the surface, first repairing the pavement so as to bring it uniformly approximately 2 inches below the finished surface; then makes a very light application of A. C. and surfaces with 2 inches of asphaltic concrete placed hot and thoroughly rolled.

Camden, N. J., lays complete asphalt top with binder on old concrete pavements.

Roselle Park, N. J., repairs cracks with Tarvia X and covers the surface with Tarvia A and sand.

Port Chester, N. Y., applies asphalt and grits to old concrete pavements.

In Waverly, N. Y., the concrete is thoroughly washed, dried and swept clean and about ¾ gallon of Tarvia X to the square yard is put on with a force distributor and covered with a thin layer of pea sized screened gravel scattered evenly over the surface.

In Greensboro, N. C., city manager P. C. Painter has found "that in laying concrete pavements, due to their short life, it is advisable to lay them with a little greater gutter face than would normally be the case, so that they can be resurfaced later with either bituminous concrete, sheet asphalt, brick or any other type of material which traffic conditions at the time of resurfacing would seem to justify."

Perrysburg, Ohio, last year laid 3,500 square yards of asphaltic concrete on old 6-inch concrete pavement.

Ada, Okla., resurfaces concrete with rock asphalt.

Hugo, Okla., has resurfaced 5,000 square yards with rock asphalt.

Denton, Tex., has used a coat of asphalt, 0.2

*Continued from page 83.

gallon per square yard, covered with sand, with good results.

Oshkosh, Wis., builds most of its cement concrete streets with a tar-gravel-sand mat, which protects the concrete from wear and does not crack or disintegrate. Repairs are made by using a power oiler distributing Tarvia A or any good distilled tar and covering this with roofing gravel or fine crushed stone and sand. "This repair is very cheap and effective for light or medium residence traffic."

OTHER KINDS OF PAVEMENT

Lafayette, Ind., last year resurfaced about 15,000 square yards of sheet asphalt with 3-inch brick using asphalt filler.

Highland Park, Mich., resurfaced old asphalt block pavements with tarvia covered with fine crushed limestone and rolled.

Oberlin, Ohio, has resurfaced 3 blocks of asphalt block pavement which had failed after 9 years of service in two ways: On one block the old blocks were removed and replaced with cement concrete and 2 inches of bituminous concrete, while in the other 2 blocks the depressions in the asphalt block pavements were leveled up with bituminous concrete and the whole pavement then covered with 2 inches of bituminous concrete. This work was done 3½ years ago and is still in good condition without any repairs.

Des Moines, Ia., resurfaces over asphaltic concrete and bitulithic as follows: The surface is thoroughly cleaned by flushing and deep depressions are filled with low penetration A. C. close mix binder, and thoroughly rolled. The primer coat of asphalt cut back in naptha is applied and evaporated to stickiness. Then a course of very fine mix sheet asphalt, using a penetration A. C. of about 40, is applied to an average thickness of one inch and thoroughly rolled. City Engineer K. C. Kastberg says that streets treated in this manner in the spring of 1916 have shown up as good as standard sheet asphalt work. Union between the top and the old surface is very good. Care must be exercised to prevent puddles of the primer coat forming in slight depressions, as there is a tendency for them to bleed up where they are of much depth. The cost for this is about ½ the usual cost of resurfacing work.

In Altoona, Pa., bituminous pavements have been replaced with new reinforced concrete, as the city does not have any equipment for patching bituminous pavements.

MACADAM STREETS

The ordinary treatment of macadam streets is that of patching rather than resurfacing. However, some cities place new surfaces on old macadam.

Waukegan, Ill., lays brick on old macadam streets, shoulders 3 feet wide being constructed of old macadam material with 1½ gallons of asphalt per square yard applied by pouring.

Elkhart, Ind., resurfaced macadam streets with sheet asphalt in 1919, and Gary, Ind., has done the same.

Owensboro, Ky., during the past five years has resurfaced 9 miles of old macadam with bituminous concrete as follows: 2 inches of wearing surface is laid on 1½ inches of binder, with a flush coat over the finished surface. The aggregate is composed of Ohio river gravel, Ohio river sand and a very fine bank sand with about 10% of lime dust. The aggregate carries about 8% asphaltic cement, penetration about 55. The binder is laid quite close. City Engineer E. B. Shifley says that this construction is nearly perfect and is cheap and not a yard of the 9 miles has failed.

Rochester, N. Y., lays 2 inches of sheet asphalt on old macadam, specifications requiring that enough of the old material be removed to bring the pavement to the required grade and crown. The surface is then thoroughly cleaned of any organic matter and rolled with a 10-ton roller, then covered with a 1-inch binding course and 2-inch wearing surface of asphalt, both the standard sheet asphalt construction.

"Lowest and Best Bidder"

The State highway engineer of Kentucky, Joe. S. Boggs, has issued the following statement explaining a recent decision of the Highway Department to investigate the character of bidders as well as their bids:

"The laws of Kentucky give to the State Highway Commission the right to reject any or all bids at a contract letting, and require them in making an award to select the lowest and best bidder, the attention of all bidders being called to this in the advertisements of lettings to be held.

"For the past year, in addition to this, bidders whose work is unknown to the department have been required to file with their proposals a verified and sworn financial statement, a list of equipment, banking reference, and recommendations from those for whom they have formerly performed work. At some of the lettings held in recent months a few of the low bids have been rejected on account of a noncompliance with these provisions of the advertisement and award made to the contractor that the commission considered the best experienced and the most responsible. Contractors who have had their bids rejected for these reasons have sometimes seen fit to direct a great deal of censure against the officials of the department and have felt that they have been mistreated in the matter of award and that preference was being given to other contractors over them.

"In defense of this policy of the commission it is well at this time to state that because an individual or firm is low bidder on a contract at the time of letting it is no evidence that at the completion of contract they have been the best bidder. The commission owes it to the public in its selection of contractors to make its award to those that will give the highest type of service, that will inconvenience the traveling public the shortest period of time, and that will carry on the work with the least amount of engineering supervision.

"In order, however, that in the future there will be no further confusion in regard to the furnishing

of financial statements, lists of equipment, and experience records, there will be attached to each proposal a questionnaire which, when properly answered, will bring out not only the financial standing of the bidder but his past record as well. Any bidder not filling out this questionnaire will have his bid disqualified just the same as if he had failed to properly fill out the items embraced in the proposal.

"When it is shown that a bidder is not qualified to perform the work he is bidding on or has not sufficient funds to properly finance a project he will not be awarded a contract, and no apology will be made to him for the rejection of his bid. The public is entitled to the best service for the money that it invests in highway construction, and such service must not be impaired by the selection of contractors not capable of properly executing the work entrusted to them."

Regulate Motor Trucks or Destroy the Highways, Which?

By J. N. Mackall *

Maryland's experience and present laws and practice relative to heavy trucks.

It was the boast of one of the largest manufacturers of motor trucks a year ago that whenever a highway engineer brought out a new type of road his company brought out a type of truck heavy enough to destroy it. The competition between the road builder and the truck builder was an exact parallel to the competition which has gone on for ages between the safemaker and the burglar. Let us hope that always in road building, as in safemaking, the burglar has been just a little ahead of the safemakers.

Many more miles of usable highways are being destroyed every year by motor trucks carrying greater loads than those which the roads will stand than are being replaced in the same time, so that actually little or no progress has been made in most of the States in road building. Many States have records of roads constructed and destroyed before the first bonds for their construction had matured, and one Eastern State, at least, with which the writer is familiar, has roads which have been built three times from bond issues before the first bonds were paid off.

The motor truck manufacturer excused himself, as did the motor truck operator, by simply saying that the roads were not properly built, never for one moment admitting that the loads which went over them were perhaps greater than those which the roads would stand. The propaganda department of one of the large producers of a commodity entering into high grade road construction started the slogan a few years ago, "Build the road to carry the load." This slogan was extensively taken up and carried forward because it sounded so plausible. The writer took exception to it, and asked instead that a slogan be adopted, "Limit the load to one which the road will carry." Of course, this slogan did not get far, because it did not sound plausible, yet an analysis of the facts will show that it is absolutely essential.

The State of Maryland in 1918 paid dearly for the lesson which it later learned, but perhaps not too dearly. At that time trucks were permitted under the law with a maximum load of 28,000 pounds, and actually were permitted to carry any load they desired because no maximum limit was enforced. Consequently many loads of this capacity were carried and many larger. The main road in the State from Philadelphia to Baltimore to Washington was completely destroyed at many points and rendered practically valueless for its entire length because of the infinite number of breaks which came in it. Fortunately, the Legislature was in session at that time, and the public could be made to realize the great necessity for some effective regulation of motor truck traffic.

When it was proposed to limit the load to 20,000 pounds under any consideration, the manufacturers and users immediately set up a howl that industrial expansion of the country was being curtailed.

A study was made of the traffic which went over this road for a year preceding and during the time of the failure, and it was determined that if the loads carried on units of five tons or larger had been carried on units of three tons, and allowing the manufacturers' rated efficiency of the five-ton unit over the three-ton limit, the extra cost to the operators would have been $15,000. The cost of repairing this road was $600,000. Obviously, the State could no longer continue to spend $600,000 in order that a few persons might save $15,000.

The Legislature of 1918 enacted a law with three outstanding features in it:

(1) That no vehicle, of which the weight of vehicle and load combined exceeded 20,000 pounds, should be operated over the public highway at any time or under any condition.

(2) That the load coming on the road should not exceed 650 pounds per inch width of tire.

(3) That no vehicle should carry a load greater than that for which application has been made and fee paid.

The State Highway Department then felt that it was its duty to see that the law was enforced, and that whether it was practical or impractical of operation depended upon a strict enforcement of it, so that subsequent Legislatures could make whatever

* Chairman and Chief Engineer, State Roads Commission, Baltimore, Maryland.

changes were desirable. It is interesting to note here, parenthetically, that there has been no demand whatever on the part of the public operating trucks, or of dealers selling trucks in Maryland to increase these weights.

It has been clearly demonstrated previously that these heavy trucks could not be legislated off the road by high license fees. If it was desirable to get rid of them, then it must be done by positive and definite legislation, and enforcement of this legislation. The highway department equipped a crew with portable scales which could be used to weigh trucks at any point, and on the two main roads leading out of Baltimore, with permanent scales, on which all motor trucks were weighed.

The men in charge of the weighing of trucks were always accompanied by a uniformed officer from the Commissioner of Motor Vehicles, and all arrests and prosecutions were actually made by a uniformed officer. Every man whose vehicle was found to violate any of the outstanding features of the law was prosecuted, but this did not serve to effectively break up the practice of overloading. In many instances, it was more economical and satisfactory to the operator of the truck to pay a fine, if overloaded, than to discontinue the practice, so that in addition to prosecutions, the officers insisted upon the removal of all excess loads at the point where the arrest was made.

There was perhaps no positive authority to remove the overload. Neither is there positive authority for confiscating stolen property in the hands of the thief, but if the Legislature prohibited the carrying of a load in excess of 20,000 pounds, when a vehicle was detected with a greater load than this, it was obviously within the province of the State to remove the load greater than 20,000 pounds In any event, no offender has ever seriously objected to or tested the right of the State to cause the removal of the overload. This effectively and quickly broke up the practice of overloading, so that now the State of Maryland finds this traffic less than .01 per cent. overloaded. The fine for overloading would perhaps run $10, $25 and in some cases $100, but this was very small in comparison with the cost of procuring another truck to come back and pick up the overload which had been taken off on the road, especially if the overload happened to be perishable commodities. The patrolman has compelled the removal of fresh beef from overloaded trucks in the month of July. However, it was not necessary to remove this but once.

The actual enforcing of the motor vehicle law has been responsible for the elimination of road failures in the State of Maryland. Since 1918 no road in the State has been permitted to fail. True, wear and tear have occurred, but actually no single instance of a road breaking up has occurred since the overloaded truck was put off the highway. Eternal vigilance may be the price of liberty, at least, it has been accepted as a fact for many years, but the public must be brought to a realization that eternal vigilance is the price it must pay for good roads. Financially, this country cannot stand long to build roads for the abuse of the user, but it can afford to build them for the use of the public, and we may go further and say that it cannot afford not to build them for the use of the public, but there is a difference between use and abuse. The difference is perhaps small in some cases, great in others, but it exists, and it is the right of every community to see that the roads which it has built are used and that they are not abused. If use without abuse in certain localities means the limiting of the gross load to five or six tons, then this must be done. It is certainly much more satisfactory from every point of view to limit the gross load down to six tons and carry it, than to let it go to ten tons or twelve or fourteen tons, and destroy the roads, so that they will not be of service to the potential truck operator or to the traveling public.

Much sentiment has swayed road building, road maintenance and road use. It is a business surrounded by cold hard facts and until it is accepted as such, and our road problem treated as a business and not a sentimental proposition, will we have made any steps toward solving it, and those who are responsible for the building and maintaining of the nation's highways must ascertain for themselves what is best to be done, and do it, and not be swayed by the truck manufacturer or the truck user, who desire to have roads built far beyond the ability of their neighbors to pay, in order that they may carry these very heavy loads when, where and how they please, with no regard for the economics of the situation.

Calcium Chloride for Sand-Clay Roads*

It is desired to call the attention of the maintenance engineers in particular and the highway commission in general, to an experiment with calcium chloride for dust laying and maintenance of gravel, sand-clay and top-soil roads.

Three half-mile sections of road, one each of gravel, sand-clay and top-soil have been selected near Raleigh for experimental treatment with calcium chloride. The gravel road section is on the Cary road and extends through the town of Cary. The sand-clay section is on the Wendell road just east of the corporate limits of Raleigh. The top-soil section is on the Fuquay Springs road beyond the experimental bituminous sections south of Raleigh. The first application of calcium chloride has been made on these sections and successive treatments will be made as deemed necessary.

Calcium chloride has been used extensively on gravel roads with considerable success in other States, but its use on sand-clay and top-soil roads has been very limited so that development of the experimental stretches on these types of roads will be watched with interest. The experiment is being conducted by the Division of Tests and Investigation under the direction of E. R. Olbrich, construction engineer.

Calcium chloride is a white deliquescent salt, and is obtained from two sources, namely (1) as a by-product in the manufacture of soda-ash, (2) from the salt brine pumped from underground streams in regions of salt deposits.

The term "deliquescent" is applied to those salts

* From "North Carolina Highway Bulletin."

which have the power of absorbing moisture from the air to such an extent that they are completely dissolved in the water thus formed.

Calcium chloride as a dust layer and maintenance material for gravel roads is not a new or experimental project. Connecticut, which has a large mileage of gravel roads, has used it successfully for many years. Leroy Ulrich, maintenance engineer of the Connecticut State Highway Department, has written many articles on its use on gravel roads. The Bureau of Public Roads, Washington, D. C., issues publications which deal with the use of calcium chloride on gravel and macadam roads. Michigan has used calcium chloride for a period of ten years in increasing amounts until at this time it is the generally accepted maintenance material for gravel roads in that State.

In the early use of calcium chloride it was shipped in liquid form in tank cars and applied to the road by sprinkling wagons. In more recent years it has been produced in the granular and flake forms. The flake form is best suited to road work, as it is possible to ship it in moisture-proof sacks of 100 pounds weight. In this form the material may be more easily handled and may be stored like cement until ready to be used, thus eliminating demurrage on tank cars.

When applied to the gravel road surface the individual flakes of calcium chloride attract and hold moisture, melting down into the road surface, leaving it with a damp appearance exactly as if a light rain had fallen. By storing a sufficient amount of moisture in the road surface it holds down the fine material which produces the dust nuisance, at the same time preserving the road surface by keeping the fine material in place on the road. It will be noticed on the gravel road treated with calcium chloride that, under the action of traffic, the gravel will pack down into a smooth firm surface. With repeated applications, and as the calcium chloride works into the surface, this result will become more evident. It will, however, not produce a hard crust or mat which later breaks through in numerous places, forming pot-holes and producing a very rough condition of road surface. Whenever necessary the gravel road surface treated with calcium chloride may be floated over with a drag, as there is always a sufficient amount of moisture present to make dragging effective at any time. The ease with which a smooth surface may be maintained on a gravel road with the use of calcium chloride and occasional dragging is one of the most important and unique features of the material, and one which appeals to the gravel road maintenance man.

Calcium chloride is more easily and cheaply applied, and can be successfully applied under less restrictions as to weather conditions and character of road surface than any other material, but there are certain limitations to the use of the material which should be understood. The surface of the road should be such that it will assist the calcium chloride in retaining the moisture attracted by it. For that reason, it is not advisable to apply it to a gravel road which has been previously treated with oil, untll such time as the oil has lost its effect, and will not longer prevent the absorption of the calcium chloride into the road surface.

The question is often asked, "What is the effect of rain on a calcium chloride treatment?" Experience has shown that the calcium chloride is not washed from the gravel road surface by the rain, but rather it is absorbed into the surface like a blotter.

APPLYING FLAKE CHLORIDE

Calcium chloride in the flake form is easily and cheaply applied to the road by means of a lime spreader. The usual method is to load the material in sacks into a three or five-ton truck which has a lime spreader attached on the rear. A two-man crew is sufficient, one man driving the truck and the other man opening the sacks and feeding the material into the spreader. Ten miles, or more, of sixteen foot gravel road may be thus treated per day if the material is so located as to eliminate the necessity of the truck making long hauls.

In applying the material, the road should be shaped up in the spring after the frost is out of the road. Two treatments of calcium chloride are sufficient for the average gravel road in the Northern States and will cost from 2½ cents to 3½ cents per square yard, applied on the road, or at the rate of $250 to $350 per mile of sixteen foot road, per season, varying somewhat with the freight rate and local conditions. In the Southern States with a longer and hotter summer three treatments per season will probably be necessary. The repeated applications are not objectionable as each application is quickly and cheaply made, and it is not necessary to close the road to traffic during the application.

Calcium chloride is odorless and not objectionable from the standpoint of being tracked into the house or damaging the clothing of pedestrians. It has no effect on rubber tires. Laborers should wear canvas gloves and rubber boots in handling the material. If a lime spreader is used for applying the material it should be washed free of the salt after using, and the metal parts lightly coated with a thin oil to prevent corrosion.

Sludge Digestion in Albuquerque

Albuquerque, New Mexico, has voted the necessary bonds for constructing a sewage treatment plant and expects to start construction on the same this Fall or early next Spring. Plans that have been prepared call for two units of single-story sedimentation tanks 22 feet deep with hopper bottoms with a sludge digestion tank located between them. The group of three tanks will have outside dimensions of 100 feet by 90 feet. The sewage will be taken out from a 42-inch outfall sewer which at present discharges in the Rio Grande river and will pass through the two sedimentation tanks, from these into a mixing chamber and chlorination plant, and the effluent from these will be discharged back in the same 42-inch sewer near its outlet into the river. In addition there will be a sludge drying bed, to which the sludge will be pumped a height of 20 feet because of the swampy nature of the plant site. The plant is designed for the sewage from a population of 30,000 people, which will be entirely domestic.

Money Available for Highways

The Bureau of Public Roads has estimated that there will be available for highway construction during the coming year approximately $800,000,000, this including both federal and local funds. The states having available the largest amount include California with over $53,000,000, Pennsylvania with over $52,000,000, Illinois and New York with more than $47,000,000 each, and Texas with almost $43,000,000.

Training Road Inspectors

The State of North Carolina, in connection with the carrying out of its $50,000,000 highway program, has recently instituted a course of instruction for highway inspectors. The course is not an elaborate one but consists in taking the men into the laboratory for about a week to familiarize themselves with the different tests that are made of asphaltic and other road materials, and listening to lectures by highway engineers and others. The men are then taken to the asphalt plant and instructed in the duties of plant inspector, and then to the road for instruction as to the inspector's duties there.

Effort is being made to obtain inspectors from each of the highway districts for work in that district, thus permitting each man to serve as inspector in the district in which he lives.

Engineering Employment Service

An employment service for engineers who are members of the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Mining and Metallurgical Engineers or of the American Institute of Electrical Engineers is being conducted by the Federated American Engineering Societies. This service is in a position to supply engineers and technical men having every variety of training and experience to those who need them, or to assist such men to find positions. It is under the direction of W. V. Brown as manager of the Engineering Service Bureau, the office of which is located in the United Engineering Building, No. 29 West 39th Street, New York City. The service is free to employer and employee.

Sanitary Engineers Wanted

U. S. Civil Service Commission announces examinations for technical assistant, junior assistant and assistant in sanitary engineering, the salaries being from $1,500 to $1,800, $1,960, and from $2,500 to $3,250 respectively, with the bonus allowed by Congress of $20 per month. Applicants for technical assistant must have had a four years' college course two of which must have been devoted to special training in sanitary engineering, or eight years of study and experience in sanitary engineering. Applicants for junior assistant must have had, in addition to the above, not less than one year of post-graduate training or experience in sanitary engineering. Applicants for assistant sanitary engineer must have had two years of such post-graduate training or experience.

Valuation Engineers Wanted

The Civil Service Commission will receive applications until October 1 for valuation engineers in general mining, coal mining, oil and gas, and the forest industry. Their services will be used by the Bureau of Internal Revenue in connection with the income tax. Positions pay from $3,600 to $4,800 a year. There will be no written examinations, but ratings will be based upon education, training, experience and physical ability.

Highway Research Specialist Wanted

The United States Civil Service Commission announces a competitive examination for Highway Research Specialist, receipt of applications to close September 12. Grade I receives salaries of $1,800 to $3,000 a year, or $6.00 to $10.00 a day, and grade II receives $3,000 to $4,500 a year, or $10.00 to $12.50 a day. Applicants must have had at least six years' preliminary training in civil, structural, mechanical, electrical or chemical engineering, each completed year of an engineering course being considered equivalent to not more than eighteen months of experience. They must also have had at least three years' practical experience, of which at least one shall have been in the direction or performance of investigational work.

Appraisal Engineer Wanted

The United States Civil Service Commission announces an examination for Appraisal Engineer at a salary of $3,000 to $4,000, receipt of applications to close August 29. Applicants must have had training equivalent at least to graduation with a bachelor's degree in engineering, and four years of highly responsible engineering experience on buildings or other structures, at least one year in appraisal work within five years of the date of the examination.

Fellowships in Highway Engineering and Highway Transport

The University of Michigan will award two Fellowships not later than September 1 and two more not later than November 1, which Fellowships pay the sum of $250 with an allowance of $50 for expenses, and holders need not pay tuition fees. A Fellow must hold a bachelor's degree from a college of recognized standing and enroll as a candidate for the degree of Master of Science or Master of Science in Engineering. He must be in residence either from October to February, from December to March or from February to June. The Fellowships are known as the Roy D. Chapin Fellowship in Highway Transport, the Roy D. Chapin Fellowship in Highway Engineering and two Detroit Edison Fellowships in Highway Engineering. Information may be obtained by addressing Professor Arthur H. Blanchard, Engineering Building, University of Michigan, Ann Arbor, Michigan.

Tabulated Sewerage Data

From several hundred city engineers in all parts of the country, giving the amounts and kinds of sewers laid during 1921 and 1922, jointing material used in pipe sewers, and other details.

Comparatively little sewer work has been done since the war interfered with this and other classes of public work, and it has therefore been several years since this Journal thought it worth while to collect figures concerning the amount of this kind of work that had been done during the recent past, as it was our practice to do annually some years ago.

Even now sewer work has not resumed its former activity, to judge by the reports made to us by engineers of a considerable percentage of the more than 1,500 cities to which questionnaires were sent. Apparently the majority of these cities did no sewer work during 1921 and are doing none this year, several hundred stating this definitely, while an even great number apparently leave it to be inferred.

The important place which sewerage holds in the public works of the country, however, is apparent even during these years of meagre construction. With only the comparatively few cities reporting construction, the lengths recorded therein total nearly 7,000,000 feet. The greater part of this is sewer less than 24 inches diameter, this totaling about 5,600,000 feet. A considerable part of the remainder are large sewers, about 194,000 feet being brick sewers, 163,000 concrete sewers built in place without reinforcements, 104,000 concrete sewers with reinforcement, and 103,000 being segment block sewers. If we assume an average cost of $2.00 a foot, which is probably under the 1921 cost, including manholes and other appurtenances, we have a total of nearly $14,000,000 spent last year for constructing sewers in the comparatively few cities listed in the tables. This does not include what was spent for sewage treatment plants, sewage pumping plants, etc., nor for sewerage maintenance.

Comparing the kinds of sewers, the number of cities tabulated would certainly seem to be sufficient to indicate with considerable precision the present tendency as to materials. Taking the sewers built in place, which range from 24 inches to 156 inches, we find that there were 194,000 feet of brick sewers, 267,000 feet of concrete (nearly two-thirds of which was without reinforcement), and 103,000 feet of segment block sewers. We were somewhat surprised to find from these figures that such a considerable amount of brick sewers was still being laid as compared to concrete sewers.

In pipe sewers we find vitrified clay greatly exceeding cement concrete, the proportion being some-

(Continued on page 133)

Large Sewer Built in 1921 and 1922

City and State	Brick Sewers Dimensions	Brick Sewers Length	Concrete Sewers Without Reinforcement Dimensions	Concrete Sewers Without Reinforcement Length	Concrete Sewers With Reinforcement Dimensions	Concrete Sewers With Reinforcement Length	Segment Block Sewers Dimensions	Segment Block Sewers Length
Alabama								
Montgomery	....	....	....	....	60"	540	....	....
Illinois								
Danville	....	....	....	....	....	....	33"	1,570
	....	....	....	....	....	....	36"	560
	....	....	....	....	....	....	42"	900
	....	....	....	....	....	....	48"	760
Indiana								
Gary	24" to 96"	19,860	30" to 96"	88,510	30" to 54"	5,200	....	....
Muncie	....	....	....	....	....	....	36" to 30"	2,400
Kansas								
Pittsburg	....	....	....	....	96"	106	....	....
Kentucky								
Ashland	30"	1,650	....	....	....	....	....	....
	33"	2,650	....	....	....	....	....	....
	54"	500	....	....	....	....	....	....
	60"	750	....	....	....	....	....	....
	63"	1,700	....	....	....	....	....	....
Paducah	....	....	....	....	102" to 96"	7,900	78" to 42"	6,150
Maine								
Portland	....	....	....	....	36" x 36"	221	....	....
Waterville	....	....	....	....	....	....	48"	650
	....	....	....	....	....	....	54"	340
Massachusetts								
Cambridge	....	....	....	1,162	....	....	....	....
Fall River	30"	206	....	....	....	....	....	....
	28" x 42"	117	....	....	....	....	....	....
	26" x 39"	4	....	....	....	....	....	....
Lawrence	36"	670	....	....	....	....	....	....
Lowell	16" to 72"	133,400	....	....	....	....	....	....
New Bedford	....	....	....	....	....	....	30"	1,104
	....	....	....	....	....	....	33"	2,036
	....	....	....	....	....	....	36"	1,096
Pittsfield	....	....	....	....	30"	1,212	....	....
Springfield	....	....	....	7,400	....	....	....	....
Waltham	....	....	....	....	....	....	30" to 42"	799
Worcester	....	....	72"	80	72"	1,208	....	....

Large Sewers Built in 1921 and 1922 (Continued)

City and State	Brick Sewers Dimensions	Brick Sewers Length	Concrete Sewers Without Reinforcement Dimensions	Concrete Sewers Without Reinforcement Length	Concrete Sewers With Reinforcement Dimensions	Concrete Sewers With Reinforcement Length	Segment Block Sewers Dimensions	Segment Block Sewers Length
Michigan								
Kalamazoo	....	....	....	....	....	....	18"	2,000
	....	....	....	....	....	....	30"	4,734
	....	....	....	....	....	....	54"	2,969
Muskegon Hgts.	....	....	....	....	....	....	30" to 48"	4,979
Pontiac	30" to 48"	9,900	....	1,200	....	14,000	....	....
Sault Ste. Marie	....	....	48"	600	....	....	....	....
Grosse Pt. Farms	....	....	....	....	....	....	36"	1,700
Minnesota								
Faribault	....	....	....	....	....	....	36"	2,917
St. Paul	....	....	....	....	42"	3,500	....	....
Mississippi								
Hattiesburg	....	....	....	....	3' x 10'	650	....	....
Missouri								
St. Louis	108"	546	....	....	144"	2,720	60"	1,000
	66"	90	....	....	96"	1,742	45"	3,995
	....	....	....	....	....	....	42"	900
Montana								
Billings	....	....	....	....	....	....	36"	1,840
Great Falls	....	....	....	....	....	....	....	150
Nebraska								
Lincoln	....	....	....	....	....	....	42"	216
Omaha	....	15,560	....	....	....	....	....	....
New Hampshire								
Concord	....	....	....	....	....	....	33"	473
New Jersey								
Freehold	....	....	18" x 21"	700	....	....	....	....
New York								
New York	....	....	....	....	6'3" x 12'	1,600	....	....
	....	....	....	....	5' x 7'6"	800	....	....
	....	....	....	....	....	....	60"	1,392
	....	....	....	....	....	....	54"	1,982
Niagara Falls	42"	40	....	....	....	....	51"	1,724
	....	....	....	....	....	....	48"	1,081
	....	....	....	....	....	....	44"	846
	....	....	....	....	....	....	42"	589
	....	....	....	....	....	....	36"	271
	....	....	....	....	....	....	42"	317
Rochester	....	....	....	....	....	....	45"	1,456
	....	....	....	....	....	....	60"	1,085
	....	....	....	....	....	....	66"	385
	....	....	....	....	....	....	84"	835
Ohio								
East Cleveland	60"	406	....	....	....	....	....	....
Lakewood	....	....	....	....	....	....	36"	1,566
	....	....	....	....	....	....	33"	60
	....	....	....	....	....	....	30"	500
Maumee	....	....	....	....	....	....	30"	503
	....	....	....	....	....	....	36"	2,000
	....	....	....	....	....	....	42"	1,024
	....	....	....	....	....	....	48"	36
West Park	....	....	....	....	....	....	51"	1,232
	....	....	....	....	....	....	48"	966
	....	....	....	....	....	....	42"	610
Oklahoma								
Enid	....	....	....	....	....	....	48"	375
Oregon								
Astoria	....	....	....	....	....	440	....	....
Portland	....	....	....	26,308	....	27,125	....	1,398
Pennsylvania								
Altoona	....	....	....	....	54" x 69" to 156" x 69"	3,078	72"	3,450
Chambersburg	....	....	....	....	48" x 48"	300	....	....
Ellwood City	....	....	....	....	....	114	....	....
Glassport	....	....	....	....	....	....	....	325
Harrisburg	....	....	....	....	32" x 34"	3,192	....	....
Meadville	....	....	....	....	66" x 78"	2,240	....	....
Sewickley	....	....	....	....	....	....	78"	703
Rhode Island								
Pawtucket	33"	210	44" to 60"	4,768	....	....	60" & 66"	2,697
Providence	16" to 24"	4,438	24" & 28"	2,751	....	....	....	....
South Dakota								
Aberdeen	....	....	....	....	....	....	60" to 90"	13,000
Watertown	....	....	....	....	36" to 57"	15,700	27" to 36"	900
Texas								
Beaumont	....	....	....	....	30" to 36"	5,000	....	....
Virginia								
Fredericksburg	....	....	....	....	42" to 60"	180	....	....
Richmond	60"	855	....	....	84"	1,500	30" to 57"	12,700
Washington								
Everett	....	....	....	26,000	....	1,000	....	....
West Virginia								
Bluefield	....	....	48" x 72"	500	....	....	42"	100
Wisconsin								
Janesville	....	....	30" & 36"	3,293	....	....	....	....
La Crosse	....	....	....	....	36" & 39"	1,822	30" & 33"	806

Pipe Sewers Laid in 1921 and 1922

City and State	Length in pipe—Vitrified clay feet: Less than 24"	From 24" to 36"	Larger than 36"	Cement concrete pipe—Length in feet: Less than 24"	From 24" to 36"	Larger than 36"	Other kinds of pipe sewers: Kind	Size	Length in feet	Jointing material other than cement mortar
Alabama										
Montgomery	7,766	1,853	.....	.....	.....	.....	.....	....	....	none
Arizona										
Bisbee	350	....	.....	.....	.....	.....	.....	....	....	none
Miami	....	....	.....	45,000	.....	.....	.....	....	....	none
Yuma	70,000	....	.....	.....	.....	.....	.....	....	....	.....
Arkansas										
Ft. Smith	2,300	....	.....	600	.....	.....	.....	....	....	none
Pine Bluff	47,300	....	.....	.....	.....	.....	.....	....	....	none
Arizona										
Nogales	2,400	....	.....	500	.....	.....	.....	....	....	none
California										
Alameda	6,000	....	.....	.....	2,000	10,500	.....	....	....	.....
Anaheim	4,100	....	.....	.....	.....	.....	.....	....	....	none
Burlingame	8,040	....	.....	.....	.....	.....	.....	....	....	none
Calexico	20,000	1,000	1,500	.....	.....	.....	.....	....	....	.....
Eureka	2,424	....	.....	.....	576	.....	.....	....	....	none
Napa	1,235	....	.....	.....	.....	.....	.....	....	....	.....
Palo Alto	6,773	....	.....	10,623	.....	.....	.....	....	....	.....
Parkeville	1,200	....	.....	.....	.....	.....	.....	....	....	none
Redlands	291,500	....	.....	.....	.....	.....	.....	....	....	.....
Santa Maria	5,300	....	.....	.....	.....	.....	.....	....	....	.....
South Pasadena	10,000	....	.....	.....	.....	.....	.....	....	....	none
Venice	12,255	....	.....	.....	.....	.....	.....	....	....	none
Visalia	8,095	....	.....	.....	5,604.5	.....	.....	....	....	.....
Colorado										
Monte Vista	1,600	....	.....	.....	.....	.....	.....	....	....	none
Connecticut										
Ansonia	3,600	....	.....	.....	.....	.....	.....	....	....	.....
Bristol	4,248	....	.....	.....	.....	.....	.....	....	....	.....
Hartford	15,758	....	.....	.....	.....	.....	reinforced concrete cast iron	....	754 92	asphalt composition
Middletown	8,200	....	.....	.....	.....	.....	Armco iron	....	4,000	.....
Stratford	100,000	50,000	.....	.....	.....	.....	.....	....	....	S. P. C. compound
Florida										
Jacksonville	2,107	....	.....	2,100	3,165	200	reinforced concrete	36x72	1,800	none
Lakeland	2,000	....	.....	.....	.....	.....	.....	....	....	.....
St. Augustine	38,000	....	.....	.....	.....	.....	iron	12"	500	.....
St. Petersburg	5,622	2,788	.....	4,396	2,903	2,634	cast iron outfall	20"	1,200	.....
Georgia										
La Grange	5,827	....	.....	.....	.....	.....	.....	....	....	.....
Newan	125	....	.....	.....	.....	.....	.....	....	....	.....
Idaho										
Boise	4,754	....	.....	.....	.....	900	.....	....	....	jointite
Pocatello	8,100	....	.....	.....	.....	.....	.....	....	....	none
Illinois										
Benton	106,833	3,323	.....	.....	.....	.....	cast iron	8" to 18"	418	.....
Beardstown	12,000	....	.....	.....	.....	.....	.....	....	....	.....
Canton	1,729	....	.....	.....	.....	.....	.....	....	....	.....
Chicago	213,000	700	.....	.....	.....	.....	.....	....	....	.....
Crystal Lake	57,450	....	.....	.....	.....	.....	.....	....	....	.....
Danville	25,000	500	.....	.....	.....	.....	.....	....	....	none
Cala	3,000	....	.....	.....	.....	.....	.....	....	....	none
Edwardsville	540	....	.....	.....	.....	.....	.....	....	....	none
Glenview	21,600	1,600	.....	.....	.....	.....	.....	....	....	none
Morrison	3,166	....	.....	.....	.....	.....	.....	....	....	none

Murphysboro	3,200	1,470								
Waukegan	6,450									
West Hammond	4,200									none
Indiana										
Bloomington	20,000	800								none
Fayette	51,142	1,522				2,810				none
Gary	22,525	2,280								
Huntington										none
Logansport	3,500									oakum and pitch
Muncie	16,950	2,000			2,400	7,400				none
Michigan City		1,000								none
Terre Haute	13,000									none
Iowa										
Cedar Rapids	16,875									
Charles City	19,694									none
Keokuk	1,000									none
Preston	16,376									
Kansas										
El Dorado	1,500									none
Fort Scott	37,000						cast iron	12"	720	
McPherson	8,106									none
Pittsburg	13,200									none
Salina	11,500									none
Topeka	17,743	2,225					cast iron (to flush tanks)	2"	8,003	
Kentucky										
Ashland	84,700	22,400								
Ft. Thomas	1,000									none
Madisonville	36,550	1,030								none
Paducah	6,100	15,100								
Louisiana										
Columbia	1,100									none
Maine										
Augusta	10,241									none
Gardiner	3,621									none
Portland	7,578	4,775			221		cast iron	8"	156	
Rockland	934									none
S. Paris	400									
Waterville	7,200									
Maryland										
Baltimore	444,370	3,480			11,500 a		Armco pipe	14" to 20"	1,200	bituminus compound
Hagerstown	65,000									G. K. comp.; S. P. C. comp.
Massachusetts										
Andover										G. K. compound
Braintree	1,500									
Brockton	32,300	4,700				1,350				G. K. compound
Brookline	1,221									asph., G. K. comp., sulph.
Cambridge	8,699									none
Dedham	2,837									
Fall River	9,004						cast iron	10" & 12"	94	none
Fitchburg	17,018									G. K. compound
Haverhill	6,440									none
Holyoke	5,500									none
Lawrence	3,000									none
Lowell	9,942									
Lyon	4,348	625								none
Medford	9,975									
Milton	4,000									none
New Bedford	23,189	2,775					iron	8"	558	
N. Attleboro										G. K. compound
Orange	328									none
Peabody										asphalt
Pittsfield	6,310	975					iron	48"	110	
Springfield	39,250	1,400								none
Waltham	5,700									G. K. compound
Worcester	1,940	4,800								none

a—Includes sizes up to 60-in. diameter.

Pipe Sewers Laid in 1921 and 1922—(Continued)

City and State	Vitrified clay pipe—Length in feet: Less than 24"	Vitrified clay pipe—Length in feet: From 24" to 36"	Vitrified clay pipe—Length in feet: Larger than 36"	Cement concrete pipe—Length in feet: Less than 24"	Cement concrete pipe—Length in feet: From 24" to 36"	Cement concrete pipe—Length in feet: Larger than 36"	Other kinds of pipe sewers: Kind	Other kinds of pipe sewers: Size	Other kinds of pipe sewers: Length in feet	Jointing material other than cement mortar
Michigan										
City of Three Rivers	3,950	....	.....	.....	.....	.....	.....	....	....	.....
Escanaba	2,000	2,600	.....	.....	.....	.....	wood stave force main	16"	5,100	G. K. or Jointite in wet trenches
Grand Rapids	27,042	....	.....	40,212	2,830	.....	.....	....	....	none
Grosse Pt. Farms	10,817	3,224	.....	....	.....	.....	segment block	36"	1,700	none
Iron Mountain	43,650	....	.....	.....	.....	.....	cast iron	8"	1,850	G. K. comp. and Jointite
							steel	20"	744	
Kalamazoo	65,083	14,779	.....	.....	.....	.....	.....	....	....	none
Muskegon Hgts.	61,296	3,087	2,261	.....	.....	.....	.....	....	....	none
Mt. Clemens	3,719	....	.....	.....	.....	.....	.....	....	....	none
Pontiac	11,883	....	.....	6,000	4,390	11,396	cast iron	24"	862	G. K. compound
Sault Ste. Marie	800	1,600	.....	.....	.....	.....	.....	....	....	none
Minnesota										
Bemidji	2,200	....	.....	.....	.....	.....	.....	....	....	none
Cloquet	2,910	....	.....	.....	.....	.....	.....	....	....	none
Faribault	114,772	3,334	.....	.....	1,640	.....	.....	....	....	.....
Little Falls	9,000	1,500	.....	.....	.....	.....	.....	....	....	.....
New Ulm	6,525	860	.....	.....	.....	.....	.....	....	....	none
Red Wing	8,036	684	.....	.....	.....	.....	.....	....	....	none
Rochester	37,496	3,298	.....	.....	.....	.....	.....	....	....	Jointite below water level
St. Paul	34,423	1,433	.....	.....	.....	.....	.....	....	....	none
Winona	44,745	....	.....	.....	.....	.....	cast iron	18"	400	bituminous filler
Mississippi										
Canton	1,800	....	.....	.....	.....	.....	.....	....	....	.....
Greenwood	1,500	....	1,200	.....	.....	.....	.....	....	....	.....
Hattiesburg	9,000	492	1,206	1,166	.....	.....	.....	....	....	none
Laurel	3,500	....	.....	.....	.....	.....	.....	....	....	none
Missouri										
Boonville	2,000	....	.....	.....	.....	.....	.....	....	....	none
Fulton	1,300	....	.....	.....	.....	.....	.....	....	....	none
Joplin	....	....	.....	112,935	12,379	600	.....	....	....	joint compound
St. Louis	27,800	5,570	.....	.....	.....	.....	.....	....	....	none
Sedalia	900	....	.....	.....	.....	.....	.....	....	....	none
Montana										
Billings	41,849	1,090	.....	.....	4,167	2,541	.....	....	....	none
Great Falls	3,870	....	.....	.....	.....	.....	.....	....	....	none
Kalispell	6,200	....	....	....	.....	.....	.....	....	....	none
Lewistown	800	....	.....	.....	.....	.....	.....	....	....	none
Livingston	3,300	....	.....	.....	.....	.....	.....	....	....	none
Marshall	900	1,400	.....	.....	.....	.....	.....	....	....	none
Nebraska										
Fairbury	2,400	....	.....	.....	.....	.....	.....	....	....	none
Fremont	....	....	.....	4,500	.....	.....	.....	....	....	none
Hastings	1,300	....	.....	2,210	.....	.....	.....	....	....	.....
Lincoln	96,016	2,507	.....	.....	.....	.....	.....	....	....	none
Omaha	163,543	17,080	.....	.....	.....	2,180	.....	....	....	none
Scottsbluff	7,093	....	.....	.....	.....	.....	.....	....	....	.....
Nevada										
Reno	....	....	.....	12,430	.....	.....	.....	....	....	none
New Hampshire										
Concord	2,588	745	.....	.....	.....	.....	.....	....	....	jointite
Laconia	....	....	.....	.....	.....	.....	.....	....	....	none
New Jersey										
Bound Brook	9,071	1,280	.....	1,390	.....	.....	.....	....	....	none
Freehold	6,000	....	.....	.....	.....	.....	.....	.....	.....	jointite
Newark	15,600	....	.....	570	5,800	265	cast iron	12"	24	jointite
Phillipsburg	27,000	500	.....	.....	.....	.....	cast iron	12"	1,400	.....
								10"	200	

jointite
jointite

Rahway	5,400	....	.....	.....	.....	.....	.....	....	....	jointite
South Orange	4,000	....	.....	.....	2,000	.....	.....	....	....	jointite
Summit	4,150	....	.....	.....	.....	.....	.....	....	....	jointite and G. K.
Wallington	12,967	....	.....	.....	.....	.....	.....	....	....	.....
Westfield	....	....	.....	.....	.....	.....	.....	....	....	G. K. compound
New Mexico										
Albuquerque	2,000	....	.....	.....	.....	60	.....	....	....	none
Roswell	1,670	....	.....	.....	.....	.....	.....	....	....	none
New York										
Auburn	....	....	.....	.....	.....	.....	.....	....	....	bituminous compound
Endicott	1,700	....	.....	.....	.....	.....	.....	....	....	none
Geneva	3,500	....	.....	.....	.....	.....	.....	....	....	.....
Hudson Falls	1,200	....	.....	.....	.....	.....	.....	....	....	.....
Jamestown	....	....	.....	.....	.....	.....	.....	....	....	none
Lackawanna	7,171	....	.....	.....	.....	.....	.....	....	....	.....
Little Falls	2,400	....	.....	.....	.....	.....	.....	....	....	.....
Lockport	1,800	....	.....	.....	.....	.....	.....	....	....	.....
Mamaroneck	15,000	....	.....	.....	.....	.....	cast iron	....	17,000	G. K. compound
Newark	2,000	....	.....	.....	.....	.....	.....	....	....	.....
New York	3,500	....	.....	.....	.....	1,200	{ cast iron { wooden barrel	18" ...	600 2,600	none
Niagara Falls	39,936	3,386	.....	.....	2,788	7,157	tunnel	6"x5"	410	none
N. Tonawanda	1,020	....	.....	.....	.....	.....	.....	....	....	.....
Ogdensburg	500	....	.....	.....	.....	.....	.....	....	....	none
Poughkeepsie	7,690	300	.....	.....	.....	.....	.....	....	....	.....
Rochester	79,127	584	.....	.....	.....	.....	steel	72"	1,010	bituminous compounds
Tarrytown	2,500	....	.....	.....	.....	.....	.....	....	....	none
Wilson	29,124	....	.....	.....	.....	.....	.....	....	....	none
North Carolina										
Asheville	68,000	....	.....	.....	.....	.....	.....	....	....	G. K. compound
Greenboro	15,678	....	.....	.....	.....	.....	.....	....	....	.....
Kingston	2,100	2,400	.....	.....	.....	.....	.....	....	....	none
Lexington	....	....	.....	.....	.....	.....	.....	....	....	G. K. compound
Reidsville	18	....	.....	3	.....	.....	cast iron	....	....	.....
Rocky Mount	27,400	3,600	.....	.....	.....	.....	.....	....	....	none
Washington	17,294	3,951	.....	.....	.....	.....	.....	....	....	.....
Wilson	44,561	548	.....	.....	.....	.....	cast iron	6"	72"	none
North Dakota										
Fargo	9,758	....	.....	.....	.....	.....	.....	....	....	none
Mandan	....	....	.....	.....	.....	.....	.....	....	....	jointite
Ohio										
Alliance	14,500	500	.....	.....	1,000	3,500	brick	66"	300	.....
Bellefontain	2,400	....	.....	.....	.....	.....	cast iron	12"	800	.....
East Palestine	....	....	.....	.....	.....	.....	.....	....	....	none
East Cleveland	4,692	....	.....	.....	.....	.....	.....	....	....	.....
Elyria	10,130	....	.....	.....	.....	.....	.....	....	....	none
Findlay	15,000	....	.....	.....	.....	.....	.....	....	....	none
Fostoria	....	....	.....	.....	.....	.....	.....	....	....	none
Lakewood	13,614	3,672	1,416	.....	.....	.....	.....	....	....	none
Lancaster	5,500	2,250	.....	.....	.....	.....	.....	....	....	none
London	3,600	....	.....	.....	.....	.....	.....	....	....	none
Marietta	2,936	....	.....	.....	.....	.....	.....	....	....	.....
Marysville	....	....	.....	.....	.....	.....	.....	....	....	.....
Maumee	4,510	1,415	.....	.....	.....	.....	none	....	....	none
Niles	....	1,600	.....	.....	.....	.....	.....	....	....	none
							cast iron	{ 10"	450	.....
								{ 8"	450	
Troy	3,500	....	.....	.....	.....	.....	.....	....	....	none
West Park	38,050	5,582	.....	.....	.....	.....	.....	....	....	.....
Wooster	5,260	90	.....	.....	.....	.....	.....	....	....	none
Zanesville	17,030	1,700	.....	.....	.....	.....	.....	....	....	sewertite
Oklahoma										
Bartlesville	72,800	270	.....	.....	.....	.....	.....	....	....	none
Chickasha	5,440	....	.....	.....	.....	.....	.....	....	....	none
El Reno	3,200	....	.....	.....	.....	.....	.....	....	....	none
Enid	19,273	....	.....	.....	.....	.....	cast iron	8"	93	none
Lawton	1,700	....	.....	.....	.....	.....	.....	....	....	none
Muskogee	10,890	....	.....	.....	.....	.....	.....	....	....	.....
Oregon										
Astoria	....	....	.....	18,850	424	.....	.....	....	....	.....
Corvallis	....	....	.....	16,900	.....	.....	.....	....	....	none
Marshfield	1,700	.....	.....	.....	.....	.....	.....	....	....	none
Portland	162,779	2,761	.....	256,382	2,404	.....	.....	....	....	none
Salem	4,500	none this yr.	.....	.....	.....	.....	.....	....	....	.....

Pipe Sewers Laid in 1921 and 1922—(Continued)

City and State	Vitrified clay pipe—Length in feet			Cement concrete pipe—Length in feet			Other kinds of pipe sewers			Jointing material other than cement mortar
	Less than 24"	From 24" to 36"	Larger than 36"	Less than 24"	From 24" to 36"	Larger than 36"	Kind	Size	Length in feet	
Pennsylvania										
Altoona	11,142	837	.....	.....	1,759	551	.....	....	....	none
Beaver Falls	600	....	.....	.....	.....	.....	.....	....	....	.....
Bethlehem	9,771	5,633	.....	.....	.....	3,258	.....	....	....	none
Chambersburg	6,000	....	.....	.....	.....	.....	.....	....	....	none
Clariton	6,000	650	.....	.....	.....	.....	iron	....	60	.....
Clearfield	1,900	1,800	.....	.....	.....	.....	.....	....	....	.....
Connellsville	5,142	....	.....	.....	....	.....	.....	....	....	none
Easton	3,782	494	.....	2,364	372	.....	.....	....	....	.....
Ellwood City	8,000	....	.....	300	.....	.....	.....	....	....	.....
Glassport	2,500	4,000	.....	.....	.....	.....	.....	....	....	bituminous filter
Greensburg	4,295	334	.....	.....	.....	.....	.....	....	....	none
Greenville	1,500	....	.....	.....	.....	.....	.....	....	....	.....
Harrisburg	15,496	850	.....	.....	.....	.....	.....	....	....	.....
Luzerne	543	....	.....	.....	.....	.....	.....	....	....	none
Meadville	4,574	....	.....	.....	.....	.....	.....	....	....	.....
Middletown	500	....	.....	.....	.....	.....	.....	....	....	none
Monongahela	1,785	....	.....	.....	.....	.....	.....	....	....	.....
Nanty Glo	2,080	....	.....	.....	.....	.....	.....	....	....	none
New Castle	6,505	....	.....	.....	.....	198	.....	....	....	none
Oniontown	10,500	....	.....	.....	.....	.....	.....	....	....	none
Parkesburg	1,098	....	.....	.....	.....	.....	.....	....	....	none
Rankin	....	....	.....	.....	.....	.....	.....	....	....	none
Sewickley	2,000	....	.....	.....	.....	.....	.....	....	....	none
Wilkinsburg	2,000	2,000	.....	.....	.....	.....	.....	....	....	.....
Rhode Island										
Providence	21,116	....	.....	.....	.....	.....	.....	....	....	.....
Pawtucket	18,276	263	.....	.....	.....	.....	.....	....	....	none
South Carolina										
Orangeburg	36,582	1,321	.....	731	202	.....	.....	....	....	.....
South Dakota										
Aberdeen	14,000	8,000	.....	.....	.....	.....	.....	....	....	none
Sioux Falls	23,000	4,735	.....	.....	.....	.....	cast iron	10"	1,733	
								6"	214	none
Watertown	98,450	5,350	85	2,680	1,050	.....	cast iron	16"	4,800	asphalt and sand
Yankton	2,452	....	.....	.....	.....	.....	.....	....	....	.....
Tennessee										
Clarksville	8,500	....	.....	.....	.....	.....	.....	....	....	none
Dyersburg	3,000	500	.....	.....	.....	.....	.....	....	....	.....
Muirfreesboro	600	....	.....	.....	.....	.....	.....	....	....	.....
Texas										
Amarillo	62,200	....	.....	.....	.....	.....	.....	....	....	none
Beaumont	5,000	....	.....	4,000	.....	.....	cast iron	12"	100	.....
Brownsville	3,000	....	.....	.....	.....	.....	.....	....	....	none
Brownwood	110,880	....	.....	.....	.....	.....	cast iron	....	500	.....
City of Lufkin	6,000	....	.....	.....	600	.....	.....	....	....	none
Denton	7,861	....	.....	.....	.....	.....	.....	....	....	none
Ennis	3,000	....	.....	.....	.....	.....	.....	....	....	.....
Mineral Wells	13,200	....	.....	.....	.....	.....	.....	....	....	none
Navasota	47,000	....	.....	.....	.....	.....	.....	....	....	none
San Benito	7,626	....	.....	.....	.....	.....	.....	....	....	filtite
Utah										
Provo	16,400	....	.....	.....	.....	.....	.....	....	....	.....
Vermont										
Barre	1,200	....	.....	.....	.....	.....	.....	....	....	.....
Virginia										
Charlottesville	4,800	....	.....	.....	.....	.....	.....	....	....	none
Fredericksburg	2,960	....	.....	.....	.....	.....	.....	....	....	.....
Harrisonburg	....	....	.....	.....	.....	.....	.....	....	....	G. K. compound
Richmond	65,116	....	.....	.....	.....	.....	.....	....	....	none
Staunton	5,000	....	.....	.....	.....	.....	.....	....	....	none
Suffolk	7,220	....	.....	.....	.....	.....	.....	....	....	.....

Washington										
Aberdeen	....	....	.....	68,000	2,100	.....	.....	....	....	.....
Bellingham	....	....	.....	14,720	.....	.....	.....	....	....	.....
Centralia	3,000	....	.....	.....	.....	.....	.....	....	....	none
Everett	....	....	.....	26,000	2,700	.....	.....	....	....	none
Pryallap	....	....	.....	29,540	.....	.....	.....	....	....	none
West Virginia										
Bluefield	42,000	....	.....	.....	.....	.....	.....	....	....	.....
Fairmont	4,000	....	.....	.....	.....	.....	.....	....	....	none
Moundsville	660	....	.....	.....	.....	.....	.....	....	....	none
Wisconsin										
Janesville	43,607	....	.....	.....	66	5,832	.....	....	....	none
Moinette	5,723	....	.....	.....	.....	.....	.....	....	....	.....
La Crosse	34,628	1,219	.....	.....	1,047	775	.....	....	....	.....
Lake Geneva	4,000	....	.....	12,987	2,000	.....	.....	....	....	.....
Rhinelander	none	none		.....	.....	.....	.....	....	....	none
Sparta	900	447	.....	.....	.....	.....	.....	....	....	.....
Wisconsin Rapids	10,000	....	.....	.....	.....	.....	.....	....	....	none
Wyoming										
Sheridan	7,800	....	.....	.....	.....	.....	.....	.. ..	....	none

Details of Sewers Laid in 1921 and 1922

City and State	Sanitary sewers, feet	Storm sewers, feet	Combined sewers, feet	Surface water inlets: With catch basins	Surface water inlets: Without catch basins
Alabama					
Montgomery	3,047	7,112	....	96	....
Arizona					
Miami	45,000	....	....	....	....
Arkansas					
Ft. Smith	600	2,300	....	600	....
California					
Alameda	....	....	12,500	....	....
Anaheim	4,100	....	....	....	....
Burlingame	7.675	345	....	....	....
Calexico	20,000	....	2,500	....	....
Eureka	2,147	853	.....	6	....
Napa	....	....	1,235	10	....
Palo Alto	6,773	10,623	....	51	....
Parkeville	1,200	....	....	....	....
South Pasadena	10,000	....	....	....	....
Visalia	....	....	....	18	....
Connecticut					
Ansonia	1,600	2,000	....	9	....
Hartford	.....	.....	16,076	....	....
Middletown	8,200	4,000	....	12	....
Florida					
Jacksonville	2,107	7,598	....	42	....
Lakeland	2,000	....	....	....	....
St. Augustine	30,000	8,000	....	84	....
St. Petersburg	9,610	9,933	....	....	77
Illinois					
Beardstown	....	....	12,000	....	....
Calla	....	....	....	4	....
Canton	716	....	10,126	....	....
Danville	15,500	....	9,500	....	150
Murphysboro	....	4,670	....	....	62
Waukegan	6,450	....	....	....	....
West Hammond	....	....	4,200	25	....

City and State	Sanitary sewers, feet	Storm sewers, feet	Combined sewers, feet	Surface water inlets: With catch basins	Surface water inlets: Without catch basins
Indiana					
Bloomington	3,000	800	...	8	....
Lafayette	....	....	...	83	25
Logansport	....	....	....	14	....
Michigan City	....	....	1,000	35	25
Muncie	....	....	....	200	....
Wabash	....	....	....	397	....
Iowa					
Cedar Rapids	....	2,237	....	1,440	....
Charles City	19,694	....	....	....	....
Newton	....	....	....	30	....
Kansas					
Eldorado	500	800	....	5	....
Ft. Scott	37,720	....	....	....	....
Salina	10,000	1,500	....	....	....
Topeka	15,625	4,343	....	20	....
Kentucky					
Ashland	51,500	....	62,850	224	297
Ft. Thomas	1,000	....	....	6	....
Madisonville	35,990	1,690	....	27	12
Paducah	21,200	....	14,050	....	70
Maine					
Augusta	....	....	....	14	....
Gardiner	3,621	....	....	....	....
Portland	....	220.67	125,090	1,605	....
Rockland	934	....	....	....	....
South Paris	....	....	....	10	....
Waterville	....	....	....	12	....
Maryland					
Baltimore	408,750	51,800	....	....	602
Massachusetts					
Brockton	20,000	13,650	....	35	....
Brookline	1,221	1,152	....	12	....
Cambridge	5,216.1	4,644.6	....	23	....

Details of Sewerage Systems (Continued)

City and State	Sanitary sewers, feet	Storm sewers, feet	Combined sewers, feet	Surface water inlets: With catch basins	Surface water inlets: Without catch basins
Massachusetts (Continued)					
Dartmouth	....	3,200	....	26	....
Dedham	2,837	....	....	....	....
Fall River	3,206	108	6,110	....	....
Fitchburg	12,569	4,449	....	....	....
Haverhill	1,780	1,840	2,780	25	....
Holyoke	....	....	5,650	40 to 50	....
Lawrence	525	....	2,475	15	....
Lowell	....	....	....	3,972	....
Mansfield	....	....	....	25	....
Medford	7,457.95	2,517.05	....	21	....
Milton	4,000	....	....	....	....
North Attleboro	....	....	....	113	....
Pittsfield	....	....	....	31	....
Springfield	4,400	12,300	31,350	....	150
Waltham	3,416	2,484	....	20	....
Worcester	5,353	2,675	....	10	90
Michigan					
City of Three Rivers	1,950	2,000	....	18	....
Grand Rapids	46,233	2,130	21,721	....	....
Iron Mountain	....	....	....	5	10
Kalamazoo	35,723	29,360	....	50	400
Mt. Clemens	2,519	1,200	2,519	396	....
Muskegon Hgts.	51,248	15,397	....	46	74
Pontiac	39,969	18,086	....	222	18
Grosse Pt. Farms	....	7,340	8,401	7	26
Minnesota					
Bemidji	2,200	....	....	....	....
Faribault	90,863	31,800	....	150	20
Little Falls	5,000	....	5,500	8	....
New Ulm	....	....	6,525	....	....
Red Wing	8,036	....	684	....	....
Rochester	....	6,490	....	943	641
St. Paul	6,139	....	33,435	....	....
Mississippi					
Laurel	1,500	2,000	....	7	....
Missouri					
Boonville	4,000	....	....	....	....
Fulton	1,300	....	....	....	....
Marshall	900	1,400	....	6	....
St. Louis	4,305	....	39,158	110	39
Montana					
Billings	28,090	23,397	....	56	96
Great Falls	1,290	2,580	....	52	....
Kalispell	6,200	....	1,000	10	4
Livingston	1,700	1,600	....	10	....
Nebraska					
Fairbury	2,400	....	....	....	....
Hastings	3,510	....	....	....	....
Lincoln	95,923	2,600	....	....	24
Omaha	....	....	....	....	900
Scottsbluff	7,093	....	....	....	....
Nevada					
Reno	....	....	....	245	....
New Hampshire					
Concord	....	1,455	2,315.5	....	....
Laconia	....	....	....	950	....
New Jersey					
Bound Brook	10,461	1,280	....	6	1
Rahway	5,400	....	....	....	....
Freehold	6,000	700	....	....	....

City and State	Sanitary sewers, feet	Storm sewers, feet	Combined sewers, feet	Surface water inlets: With catch basins	Surface water inlets: Without catch basins
Ohio					
Alliance	2,000	17,800	....	120	....
Bellefontaine	3,200	....	....	....	....
East Cleveland	1,803	406	2,889	30	5
Elyria	3,620	7,510	....	52	....
Findlay	3,500	5,500	6,000	30	....
Lakewood	6,780	9,241	4,807	34	50
Lancaster	3,200	....	4,550	22	12
London	3,600	....	....	....	....
Marietta	2,476	460	....	2	4
Maumee	....	5,925	....	43	....
Niles	2,000	....	....	....	....
West Park	6,136	6,200	31,296	90	....
Wooster	4,260	1,000	....	2	....
Zanesville	18,730	....	....	....	....
Oklahoma					
Bartlesville	72,060	740	....	....	....
Chickasha	2,140	3,300	....	18	....
El Reno	3,200	....	....	....	....
Enid	19,366	375	....	....	112
Lawton	900	800	....	....	....
Muskogee	1,060	9,830	....	11	....
Oregon					
Astoria	....	....	19,714	300	....
Corvallis	....	7,800	3,000	120	....
Marshfield	....	....	1,700	22	....
Portland	....	....	479,152	....	847
Pennsylvania					
Altoona	8,234	5,280	7,304	17	....
Beaver Falls	600	....	....	....	....
Bethlehem	9,000	....	....	....	....
Chambersburg	6,000	300	....	2	....
Clairton	4,000	2,650	....	....	50
Clearfield	1,800	1,900	....	....	10
Connelsville	4,734	408	....	....	....
Freeland	....	....	....	20	12
Easton	205	6,807	....	....	....
Ellwood City	8,000	314	....	....	11
Glassport	....	....	6,500	16	....
Greensburg	4,235	394	....	3	....
Harrisburg	19,538	....	....	....	....
Luzerne	....	543	....	2	....
Meadville	2,634	4,180	....	21	....
Middletown	500	....	....	....	....
Monongahela	1,785	....	....	....	....
Nanty-Glo	2,080	....	....	8	....
New Castle	6,505	198	....	....	....
Uniontown	10,500	....	....	....	....
Parkesburg	1,098	....	....	....	....
Rankin	....	....	6,000	90	6
Sewickley	2,000	703	....	....	....
Rhode Island					
Pawtucket	5,388	865	19,961	53	11
Providence	6,087	3,152	17,068	96	....
South Carolina					
Orangeburg	31,380	7,456	....	65	....
South Dakota					
Aberdeen	1,000	34,000	....	500	100
Sioux Falls	22,540	5,195	....	....	29
Watertown	102,475	26,600	....	102	5
Yankton	2,452	....	....	....	100
Tennessee					
Clarksville	3,000	2,000	3,500	....	....
Dyersburg	3,080	420	....	....	....
Murfreesboro	....	....	600	20	10

| | | |

NEWS OF THE SOCIETIES

CALENDAR

Aug. 19-26—AMERICAN INSTITUTE OF PARK EXECUTIVES. Annual convention, Minneapolis, Minn. Secretary, Emmett Griffin, Supt. of Parks, East St. Louis, Ill.

Aug. 22-25—INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Annual convention, New Bedford, Mass. Secretary, Clarence R. George, City Electrician, Houston, Tex.

Aug. 28-Sept. 2—NATIONAL SAFETY CONGRESS. Detroit, Mich.

Aug. 29-30-31—LEAGUE OF CITIES OF THE THIRD CLASS IN PENNSYLVANIA. Annual convention, Williamsport, Pa. Fred H. Gates, Secretary, Wilkes-Barre, Pa.

Sept. 11-15—ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS. New Auditorium, Cleveland, Ohio.

Sept. 12-15—NEW ENGLAND WATER WORKS ASSOCIATION. 41st annual convention. New Bedford, Mass. Secretary, Frank J. Gifford, Tremont Temple, Boston, Mass.

Sept. 14-16—AMERICAN ASSOCIATION OF PORT AUTHORITIES. Convention at Toronto. Secretary, M. P. Fennell, Jr., Montreal.

Sept. 19-23—LEAGUE OF CALIFORNIA MUNICIPALITIES. Annual convention, Palo Alto, Cal. Executive secretary, W. J. Locke, Pacific Bldg., San Francisco.

Sept. 25-28—SOUTHWEST WATER WORKS ASSOCIATION. Annual convention, Hot Springs, Ark. Secretary, E. L. Fulkerson, Waco, Tex.

Oct. 2-6—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual convention, Cleveland, Ohio. Secretary, Charles C. Brown, St. Petersburg, Fla.

Oct. 16-19 — AMERICAN PUBLIC HEALTH ASSOCIATION. Annual meeting, Chicago, Ill. Secretary, A. W. Hedrick, 370 Seventh Ave., New York, N. Y.

Nov. 15-16—NATIONAL INDUSTRIAL LEAGUE. Annual meeting. New York City. Secretary, J. H. Beck, Chicago.

Dec. 7-13—NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING. New York City.

WISCONSIN SECTION A. W. W. A.

A Wisconsin section of the American Water Works Association was formed on June 8 and 9, forty-eight or more being in attendance. The officers chosen were as follows: President, Prof. Daniel W. Mead; vice-president, Leon A. Smith; secretary-treasurer, C. M. Baker, sanitary engineer of the State Board of Health; all of Madison. The executive committee is composed of the officers and, in addition, H. H. Grifey, of Janesville, and H. P. Bohman, of Milwaukee.

TECHNICAL SOCIETIES PLAN PUBLIC WORKS BOARD

A plan for including a State Board of Public Works in the new constitution of the State of Missouri has been prepared by the Associate Engineering Societies, a Chapter of the American Institute of Architects, and the contractors, all of the city of St. Louis. This plan provides for directors of utilities, highways, waterways, and conservation, and their president to be appointed by the Governor of the State and to have supervision of the activities of five divisions.

Division of Structures will include land, natural resources, structures, equipment and improvements in which the State is interested.

Division of Utilities includes maintenance, equipment, operation and service of all public utilities owned or operated by the State and the assessment of rates and charges therefor.

Division of Highways includes construction, reconstruction, maintenance and inspection of all public highways and bridges for which State funds are used.

Division of Waterways will include waterways, water sheds, navigation, stream pollution, fisheries, water works, irrigation projects, plant control, water for development, drainage, and sanitary matters.

Division of Conservation will deal with the conservation of resources and State planning.

AFFILIATED TECHNICAL SOCIETIES OF BOSTON

"The Affiliated Technical Societies of Boston" was granted a charter on June 12, 1922, with the following nine societies as member organizations: Boston Society of Civil Engineers, New England Water Works Association, Plant Engineers' Club, Boston Sections of American Institute of Electrical Engineers and of the Society of Mechanical Engineers, and of the American Institute of Mining and Metallurgical Engineers, Northeastern Section of the American Society of Civil Engineers, Massachusetts Chapter of the American Institute of Heating and Ventilating Engineers, and Boston Chapter of the American Association of Engineers.

The council is composed of two representatives from each affiliated organization. It has elected as its officers: Leonard Metcalf as chairman, Alfred S. Kellogg and Alexander Macomber as vice-chairmen, Charles L. Hammond as treasurer, W. G. Starkweather as clerk and J. B. Babcock as executive secretary. The members of the executive committee are Messrs. Kellogg, Macomber and Frank A. Marston, together with the president and treasurer ex-officio. Among the committees arranged for are those on publicity, program, public affairs and legislation, employment and welfare, and library.

The Affiliated Societies will use the quarters of the Boston Society of Civil Engineers, and took these over as of date of June 1, having arranged with that society for the use of its quarters, library and equipment, and a similar agreement has been made with the New England Water Works Association, whose quarters adjoin those of the Boston Society, both located in Tremont Temple, Boston. The facilities include a technical library, current engineering periodicals, rooms for committee meetings and an assembly room fitted with stereopticon.

The objects and functions of the Affiliated Societies are stated as follows:

OBJECTS AND FUNCTIONS OF THE AFFILIATION

Objects

(a) Concentration of a united membership on questions of engineering interest, of importance to the Nation, State, City or to the engineers.

(b) Correlation of local group activities, — sometimes disconnected, sometimes overlapping, and at times even interfering,—and elimination of duplication of meetings and of effort.

(c) Improvement of the standing of technically trained men.

(d) Promotion of acquaintance, furtherance of better technical activity and increased esprit de corps among members of the organization.

(e) Maintenance of headquarters for resident and non-resident technical men, with facilities for meeting and correspondence, with a reference library, and employment clearing bureau.

(f) Maintenance of adequate facilities for society or group meetings, with the necessary plant and apparatus for the proper presentation and discussion of technical and related subjects.

(g) The possible issue at some future time of a joint publication of professional papers of interest to the members of the affiliated organizations.

(h) Possible co-operation in the future with some club for the enjoyment of its facilities at times of meeting of the Affiliation, affiliated organizations or committees thereof.

Functions

(a) The keeping of general records, and membership lists of all affiliated organizations.

(b) The co-ordination of meetings and programs, and the preparation for joint meetings.

(c) The preparation, publication and distribution of a periodic bulletin with notices of the meetings of the affiliated organizations; information of general interest; current legislative matters; committee reports or abstracts thereof and other society matters approved by the Council.

(d) Co-operation with the secretaries of the affiliated societies and furnishing secretarial and other assistance to them as far as possible in sending out special notices (not published in the bulletin); bills for membership dues; subscriptions, etc.; reports of committees, ballots, typewriting and other service of like character that may be required in the conduct of the affairs of the several societies. This work shall be done through and under the direction of the Executive Secretary. The officials of the affiliated societies shall have no authority over the office assistants or staff.

(e) The clerical work incident to the collection of dues from the affiliated societies. If the Executive Secretary is asked to and shall assist the secretaries of any of the affiliated organizations in collecting dues from their members, he shall assume no responsibility for the assessment, payment and collection of these dues other than for an accurate accounting of receipts.

(f) The maintenance of a technical employment bureau.

(g) The making of library researches at the cost of the members desiring them.

(h) **Keeping in touch with like affiliations and groups of engineering societies and with American Engineering Council.**

(i) **Listing separately in the telephone directory the names of all of the affiliated organizations.**

(j) **Maintaining and developing if it shall prove practicable and advantageous a special service at a nominal charge, covering cost at least, for individual members of the affiliated organizations, under which they may receive mail, telephone and limited secretarial service at the quarters of the Affiliation.**

All of these functions are to be carried out through the office of the Executive Secretary, under direction of the Council and the Executive Committee.

This is an affiliation merely, each of the societies retaining its individuality, holding its own meetings, etc., but having at its service the machinery for united action and also the facilities for "promotion of acquaintance, furtherance of better technical activity and increased esprit de corps"; the purpose being announced by the by-laws to be "bringing technical societies and their members into close touch with one another for more effective public service, and for the advancement of scientific investigation, education and research." Like its national prototype, the Federated American Engineering Societies, it maintains a bureau for bringing togther engineers of all kinds and those who desire their services.

PERSONALS

Brown, Major Cary H., assistant engineer commissioner of the District of Columbia, will shortly be relieved of that duty and assigned to duty at the engineer school at Camp Humphreys, Va.

Weisiger, L. M., field engineer of the South Carolina State Highway Department, has resigned to accept a position with J. M. Gregory of Newton, N. C. E. D. Sloan has been appointed to succeed Mr. Weisiger.

Patterson, Charles A., borough engineer of Torrington, Conn., has resigned. He will be chief engineer of the contracting firm of Mascetti & Holley of Torrington.

Swain, Clayton E., superintendent of public works, Rockville, Conn., has resigned, and is now associated with the U. S. Bureau of Public Roads.

Kelley, Robert E., of Willimantic, Conn., has been appointed an engineer of bridge construction for the Maine State Highway Department.

King, Edwin J., for five years county engineer of Sabette Co., Kansas, has been appointed Kansas representative of the Portland Cement Association to succeed Frank Altman.

Stephenson, Edwin J., until recently employed as construction engineer by the United Light and Railway Cos., Davenport, Iowa, has been appointed chief engineer of public construction for the city of Davenport.

Brigham, John C., has been reappointed city engineer of Summit, N. J., for a term of three years.

Seventon, H. L., has resigned as assistant engineer with the California State Highway Commission and will be employed as engineer with the Western State Power & Electric Co.

Fuetter, Otto, has been appointed city engineer and street superintendent of Venice, Cal.

Vogel, John Leonard, has been appointed bridge engineer of the New Jersey State Highway Department. He was formerly designing bridge engineer of the New Jersey Public Utility Commission.

Wanzer, J. O., has been appointed city manager of Marysville, Cal. He was formerly with the California State Highway Commissioner.

Farrier, Benj. E., has been appointed successor to John Ferris as member of the New Jersey State Highway Commission. Mr. Farrier is a plumber of Jersey City.

Dixon, G. Gale, has resigned as chief engineer of the Water Department, of Akron, O., which position he had held for five years. He will engage in business in Cleveland.

Connell, William H., has been selected by the Pennsylvania Committee on State Finances to investigate the State Highway Department. He will select a committee of highway engineers to aid him. His headquarters will be 912 Real Estate Trust Building, Philadelphia.

Shoecraft, Ezra C., for nine years city engineer of Flint, Mich., on August 1 became a member of the firm of Hoad, Decker and Drury, of Arbor, Mich., the firm name becoming Hoad, Decker, Shoecraft and Drury.

Powers, Cornelius Van Vorst, chief on one of the bureaus of the New York Transit Commission and former division engineer of the commission, died in New York City, June 18, aged 62 years.

Fitzgerald, Harrison W., engineer, has been elected Mayor of the town of Hamburgh, New York.

Tuttle, Arthur S., has been appointed chief of the staff of engineers to prepare plans for the Brooklyn-Richmond freight and passenger tunnel.

Smith, H. H., has been appointed deputy chief engineer on the staff abovementioned.

Coe, D. W., has been appointed resident engineer,

Shea, Wm. J., has been appointed assistant engineer,

Phipps, Francis H., has been appointed assistant engineer, and

Conant, Wm. M., has been appointed statistician of the above tunnel staff.

Dixon, G. Gale, formerly chief engineer of the Bureau of Water Works Improvement of Akron, O., has become associated with Frank A. Barbour, consulting civil and sanitary engineer of Boston, the firm name being Barbour & Dixon.

PAMPHLET NOTES

The 1922 edition of the "List of Publications of the Department of Commerce Available for Distribution" contains the name, date of publication, number of pages, and cost (when not furnished free) of more than two thousand pamphlets, reports and other publications of the Bureau of the Census, Coast and Geodetic Survey, Bureau of Fisheries, Bureau of Foreign and Domestic Commerce, Bureau of Lighthouses, Bureau of Navigation, Bureau of Standards, and Steamboat Inspection Service. The publications of the first two and some of those of the Bureau of Standards contain matter of interest to public works engineers. 88 pages. This list can be obtained by addressing "Chief, Division of Publications," Department of Commerce, Washington, D. C.

"Flexible Strength of Plain Concrete." By Duff A. Abrams, Professor in charge of Structural Materials Research Laboratory, Lewis Institute, Chicago. Bulletin No. 11 of the Laboratory, published June, 1922.

Result of testing 750 beams, giving details of tests and conclusions, one of which is that, for the usual concrete mixtures the modulus of rupture is about 22% of the compressive strength. The effect on flectural strength of various modifications of the concrete mixture are described. 25 pages. Apply to the laboratory.

"Proposed Zoning Ordinance for Akron, Ohio." As recommended by the City Planning Commission and City Planning Committee of Council. 18 pages. Also 3-page "Report of the City Planning Commission" of June 20, 1922.

"Mosquitoes and Mosquito Control," by Geo. W. Simons, Jr., Chief Sanitary Engineer, State Board of Health of Florida, and Geo. F. Moznette, Entomologist, Bureau of Entomology, U. S. Dept. of Agriculture. Published by the Florida State Board of Health. A discussion of the economic importance of mosquitoes in Florida, their habits, and how they can be controlled—36 pages.

Fire Fighting Facilities. Reports of National Board of Fire Underwriters on the water supply, fire department, structural conditions and hazards of Pasadena and Riverside, Calif., Philadelphia, Pa., and Cicero, Ill., being reports Nos. 329 to 332, published July, 1922.

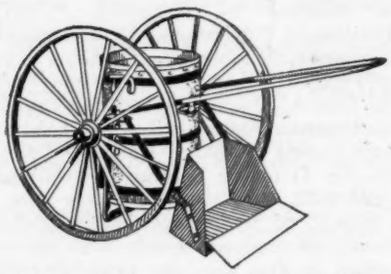
"Water Supply Needs and Resources of the Commonwealth" of Massachusetts. A report of the joint board of the State Department of Public Health and the Metropolitan District Commission. A book of 284 pages and several large folded maps and other inserts; dealing with the water supply requirements, adequacy of the present sources of supply, and new sources of supply; proposed works and their cost, and conclusions as to metropolitan district supply, including 16 cities and towns within ten miles of the State House and 9 outside this limit.

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

IRON HORSE STREET CLEANERS & SNOW SHOVELS

The Rochester Can Company, manufacturers of metalware, under the trade name of "Iron Horse," have placed on the market the type of street cleaner shown in the accompanying illustration. This consists of an iron street can carried in a frame of Bessemer steel equipped with an exceptionally good grade of 36-inch Sarvin wheels. The equipment shown is provided with a dust



"IRON HORSE" STREET CLEANER

pan attachment (it can be omitted when desired), which is attached by steel rods directly to the curved handle of the cart, in such a way that dirt swept into the pan can be dumped into the can by simply swinging the handle upward and over. The can is made of extra heavy gauge iron, reinforced top and bottom with a heavier iron band equipped with large heavy side handles.

The "Iron Horse" snow shovels are probably the most substantial made, using heavy galvanized iron wire around the outer edge and corrugated vertically, and further strengthened by three heavy steel rib enforcements riveted to the back, one of which receives the end of the handle. The point of the shovel is reinforced with a strip of steel riveted in place. The handles are made of straight grained hard wood and equipped with a wood grip. For heavy street work these are made in two sizes, one 17 inches wide at the bottom, 14 inches at the top and 14 inches high; the other 20 inches wide at the bottom, 16 inches at the top and 16 inches high.

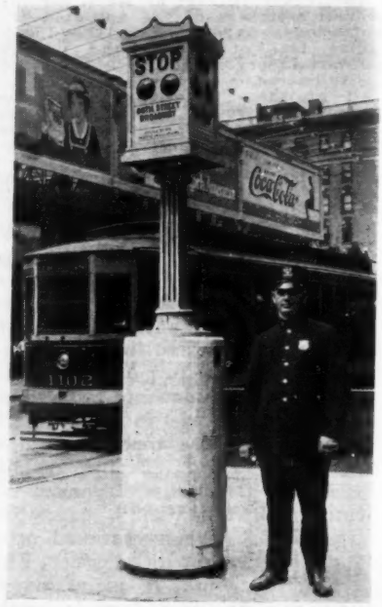
"IRON HORSE" SNOW SHOVEL

"TALKING LAMP" FOR HIGHWAY

After experiments extending over a period of about six years, Foster Milliken, president of McNab & Harlin Mfg. Co., has evolved the Milliken Electric Street Signal "Talking Lamp" which is used for either danger spots on highways or for highway traffic control. Up to this time all traffic regulating lights have depended on simple color schemes to give police regulations either by day or night. This method of control is not only unsatisfactory but unsafe, as the majority of people do not even know what the colors mean or they fail to interpret them quickly enough to avoid danger, which, owing to the fact that the Milliken Lamp gives positive instructions by means of lettering that can be easily read and understood, has been aptly termed a "Talking Lamp."

The ideas in designing this lamp were: First, to use flashing colored lights that can easily be seen at a distance of a mile or more. Second, to give full information concerning police regulations and information relative to the location or direction to the traveling public. The third object was to have all of this information directly in front of the driver so that he would not be compelled to look other than straight ahead,

ELECTRICAL CONTROL FIXTURES FOR LAMP SHOWN ABOVE



REMOTE MULTIPLE UNIT CONTROL At 86th St. and Broadway New York

and further to have all of this information clear and distinct, not only in the day time, but particularly at night. The automobilists will without thinking naturally slow down to read the lamp and thus approach the danger spot at a reduced speed which is in the interest of safety.

The design of this lamp is particularly ornamental and pleasing in appearance. The lamp is divded into three separate and distinct horizontal compartments. The upper compartments contains a fixed white light and the letterings on the glass faces are intended to give the necessary police instructions. The center compartment contains the flashing electric lights placed behind the lenses. The lenses in the center compartment may be of any color to conform to any government, state, city or municipal regulation. The lenses used in the flashing compartment of the lamp are of special construction and are exceedingly powerful so that the light will penetrate fog and mist where ordinary lights fail. The idea of having two lenses instead of a single lens is to make the lamp unique so that it cannot be confused with any other lights.

The lower compartment of the lamp contains a fixed white light, and the lettering on the glass face is generally intended to give the location or information relative to direction of principal cities or towns.

TYPE A LAMP IN CENTRAL PARK, NEW YORK

In the bottom of the lower compartment are placed refracting lenses which at night throw rays of light not only over the pedestal and base, but over a considerable portion of the roadway adjacent to the bottom of the lamp. This refracted light makes the pedestal and base glow at night bringing the lamp into sharp contrast with the black surroundings.

These lamps are now manufactured in twelve principal types for different highway conditions, such as varying angles of street intersections, stop and go signals, railroad crossings, etc.

A large number of these lamps of different types have been operating throughout the State of New Jersey since the first of the year, and some, of different types, have lately been installed in New York City.

INDUSTRIAL NOTES

C. O. BARTLETT-SNOW COMPANY

The C. O. Bartlett-Snow Company of Cleveland, Ohio, has added to its staff Irwin S. Osborn, a consulting engineer who for a number of years has made a specialty of garbage and refuse disposal. This enables the company to give the best of service in a new direction, that of building refuse destructors, in addition to the Cobwell system of garbage reduction which it has been installing in various cities during the past few years. Associated with Mr. Osborn in this new branch of the business will be Mr. Bighouse, who has been in charge of the garbage disposal work of the company for some time. The company will also retain Raymond Wells as consulting chemical engineer.

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Manufacturers of COMPRESSED AIR FIRE WHISTLES, WHISTLE BLOWERS, BELL STRIKERS, BOXES, GONGS, Etc., Etc.
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Full Line Cummer Plants in London Stock.

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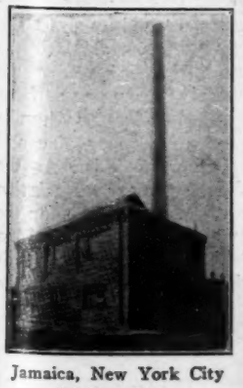

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100 Ton Plant

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We are one of the oldest concerns in the United States engaged in the erection of incinerators for the final disposal of municipal refuse.

Our plants are of a distinctive type, and of scientific design passed upon years of experience. We have over 50 municipal installations in the United States and Canada. Among these are 15 repeat orders. Write us the conditions in your city and our engineers will furnish you with preliminary plans and proposals for the proper size of plant for your requirements.

STACEY-BATES COMPANY
Selling Agents: McKnight Bldg., Minneapolis

Wilmington, No. Carolina
40 Ton Plant

EVINRUDE PUMPS

The Evinrude Motor Company is placing on the market a new pump outfit weighing less than 100 lbs. complete and having a capacity of 2,400 gallons an hour at 70 lb. pressure and 900 gallons an hour at 155 lb. pressure. The pump is a small Viking special internal gear pump which is direct connected to an Evinrude 4-5 h.p. two-cylinder, two-cycle motor with the magneto built in the fly wheel. Pump and motor are mounted on a strong aluminum base. The length overall is 31 inches, width 11½ inches, height 17 inches. The suction pipe is 2-inch and the discharge 1½-inch. Two men can carry it easily by adjustable handles, but bolt holes are provided in the base for permanent installation if desired. It can be used in fighting forest fires, on farms, summer resorts, etc., for filling pressure tanks, fire prevention, irrigation, etc. Also for small town fire departments. Contractors can use it for bringing water from a considerable distance for concrete or other purposes—it will deliver 1,500 gallons an hour through 1⅓ miles of 1¼-inch pipe. Fitted with handles, it can readily be carried by two men or a Ford car from one source of supply to another as often as desired.

ROTARY PUMP FOR CATERPILLAR TRACTOR

The Holt Manufacturing Company has recently adopted as accessory to its five-ton tractor a pump of special design and compact in size, which is attached to the rear of the tractor in the same position as the power pully attachment. It is driven direct through the countershaft from the motor and is capable of delivering 220 gallons of water per minute under working pressure of 100 pounds per square inch. At normal speed of 1,000 r. p. m. it throws a 1⅛ inch stream 100 feet in the air. It requires but 26 h. p., which is approximately two-thirds of the normal capacity of the five-ton caterpillar, and there is, accordingly, a large reserve for overloading should the pump be called upon for extra heavy duty. The pump is of the rotary gear wheel type, with all working parts mounted in a heavy cast iron case. The two main shafts are geared together at the outer end and carried in Hess-Bright anti-friction ball-bearings.

In every respect it is substantially built of the best material and is extra strong for heavy-duty service although weighing only 225 pounds. It has been developed through the co-operation of Holt engineers and the Goulds Manufacturing Co.

Suggested uses for this pump are patrol work in State forests, muncipal fire service when not engaged in road building or snow removal, pumping out flooded cellars, by contractors in pumping out excavations, trenches or cofferdams.

LOUISVILLE CEMENT COMPANY'S FIRE

The Louisville Cement Company suffered a disastrous fire at its plant near Sellersburg, Ind., on July 13. The blaze is thought to have been started by hot cement which resulted in one of the most spectacular fires in this vicinity.

The loss was confined to the brixment department which will be seriously handicapped in production, although the manufacture of Portland cement is not interfered with in any way. The loss has been estimated at about $200,000.

NATIONAL PAVING BRICK MANUFACTURERS' ASSOCIATION

The secretary of this association, Maurice B. Greenough, has presented his resignation, effective on or about January 1, 1923, to associate himself with W. M. Lassel of the Southern Clay Mfg. Co. The resignation was accepted, and a committee composed of Messrs. O. W. Renkert, C. C. Barr, S. M. Duty, W. P. Blair, and the present secretary was selected to recommend a successor to Mr. Greenough at an early date.

Stanley A. Knisely, economist of the association, was promoted to the office of assistant secretary at the recent meeting of the Board of Governors, and Miss B. L. Beller, formerly bookkeeper and office manager, was promoted to the office of assistant treasurer.

BARBOUR & DIXON

Frank A. Barbour, consulting civil and sanitary engineer, has associated with himself G. Gale Dixon, late chief engineer of the Bureau of Water Works Improvement of Akron, Ohio, under the firm name of Barbour & Dixon with offices in the Tremont Building, Boston, and Finance Building, Cleveland. The firm will continue practise in Mr. Barbour's specialty of hydraulic work, including water supply, sewerage and disposal of sewage, flood control, etc.

"SOUTHERN PINE—WHAT IT IS—WHAT IT IS USED FOR"

This book has been published for widespread distribution by the Southern Pine Association, New Orleans, with a view to supplying the requirements of architects, engineers, contractors and the building public generally, for a treatise which would set forth, in condensed form, though in sufficient detail, technical and general information regarding the Southern Pine industry and the properties and uses of the product of this industry.

It is divided into four parts: The Pines of the South; The Uses of Southern Pine; General Specifications for Southern Pine Lumber and Timbers, and Physical properties of Southern Pine, including a table of the Association's Recommended Working Stresses based on the results of the recent timber tests at Columbia University, New York City.

COAL MANUEL

Four and one-half by 6 inches, 150 pages, cloth covers, W. D. Wadley, author, National Coal Mining News, Cincinnati, publishers, $2.60.

An elementary, non-technical book, discussing the origin, structure, chemistry and uses of coal for the benefit of the users and others. The principal chapters of special interest in their bearing on construction work and the operation of public utilities are those dealing on purchases, specifications, preparation, cleaning, washing and transportation rates; samples, sampling and analysis, ash, clinkers and sulphur; uses, pulverized coal, bricquettes, instruction to engine men and firemen; boilers, furnaces, suggestions for firing and combustion; storage and spontaneous combustion.

In the discussion of hand firing of boiler furnaces there are given 23 practical suggestions, covering the principal requirements and the precautions that should be taken by firemen. Storage of coal is treated under six heads, namely: amount to be stored and time of storage, location of storage, method of storage, handling and rehandling and kind and sizes of coal to be stored and spontaneous combustion, and method of inspection of storage piles.

COMMERCIAL TRUCK COMPANY'S BIG ORDER

The Commercial Truck Company of Detroit, Michigan, which specializes in hauling for contractors on highway construction, is operating 25 Selden trucks. It recently drove thirteen of these trucks to the grounds of the Heil Company in Milwaukee for the installing of Heil dual gravity bodies, as they were to be used for road work in Wisconsin. The trucks are tractor units so that the bodies can be removed and the trucks used for hauling trailers in the winter. From Milwaukee the trucks travel to Brandon, Waukesha, and other points. A number of the drivers are taking their families with them and camping out wherever they stop along the way.

LUMBER WHOLESALERS MERGE ASSOCIATIONS

By referendum vote the membership of the Yellow Pine Wholesalers Association has concurred in the recommendation of the executive committee that a merger should be consummated with the American Wholesale Lumber Association.

The reason for the merger was given to be the condition of the producing and of the yellow pine lumber fields. Much of the stumpage of this once large supply of timber has been used up and there will only be a dwindling supply for the market from now on. Therefore the wholesalers who have been specializing in this product will be forced to handle increasing amounts of western pine and fir, as well as southern woods. As the American Wholesale Lumber Association offers to create a division to care for the needs of yellow pine merchants as long as the diminishing stocks last, it is thought that the best interests of the industry will be served by the merger.

Recorded Engineering Experience Speeds Progress

Progress would be mighty slow if students were compelled to work out for themselves every problem they encountered.

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For Engineers and Superintendents of Water Works, the following books contain a wealth of experiences.

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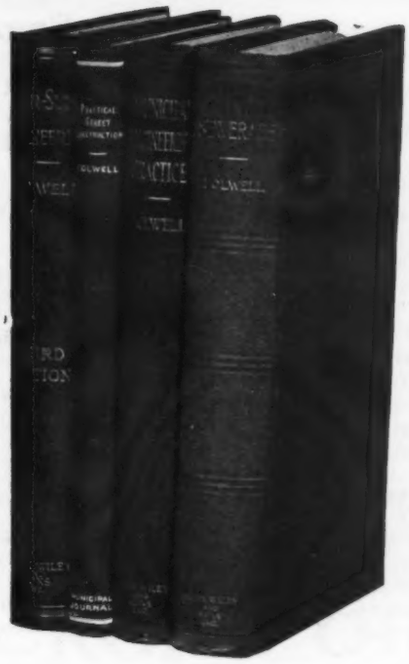

Sewerage

The Designing, Construction and Maintaining of Sewerage Systems and Sewage Treatment Plants. This rewritten edition, which has been brought strictly up to date, devotes more space than heretofore to the calculating of the sizes of sewers, especially of storm sewers, the pumping of sewerage, etc.

Eighth Edition, Rewritten and Revised; 473 pages. Cloth $4.00

Municipal Engineering Practice

The subject matter in this book fills the gaps that have been evident in municipal engineering literature, such as street lighting, waste disposal, comfort stations, etc. The author has also covered both the theory and the detailed practice of the other fields in which the municipal engineer is interested.

422 pages, 6 by 9. Cloth.....$4.00

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A new book devoted to the practical design and construction of streets. This is the only book treating of alignment, grade and cross-section, the location of sewers and other underground constructions, the above ground appurtenances, such as manholes, fire hydrants, fire alarm boxes, street signs, and other features of modern city streets.

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STREET SWEEPING MACHINE

432. The Springfield Motor Sweeper Co., Springfield, Ohio, leaflet describing Springfield Automobile Sweeper with dumping bin and steel brushes.

SAND AND GRAVEL PUMP

433. Hodge, Thomas & Sheffer, Auburn, Indiana, circular describing centrifugal pumps for dredging fine and course gravel and sand.

NEW TYPE CONCRETE PRESSURE PIPE

434. United Concrete Pipe Co., 29 Broadway, New York, circular describing the design, construction, testing and installation of large reinforced concrete pressure pipe.

TRUCK TURNTABLE

435. The Champion Engineering Co., Kenton, Ohio, leaflet illustrating the Champion automatic turntable built under the Jones' patent.

CALCIUM CHLORIDE

436. Carbondale Calcium Co., Carbondale, Pa., booklet describing the properties and application of granulated carbondale calcium chloride for road preserving.

MOUND TRAFFIC MARKERS

437. Mound Traffic Equipment Co., 184 West Spring street, Columbus, Ohio, leaflet describing perfected marker for installation in the street service.

OIL ENGINES

438. De La Vergne Machine Co., 1224 East 138th street, New York, circular describing the design, details, operation, test and specification of the Horizontal type SI De La Vergne Diesel Cup Injection Oil Engine.

VELOCITY GAUGE TURBINE

439. De Laval Steam Turbine Co., Trenton, New Jersey, catalog, 8½x11 inches, 8 pages, heavy coated paper, paper covered, describing details and principal features of steam turbines for high pressure and for high temperatures. Built in sizes up to 1200 HP and designed to be directly coupled to high speed centrifugal pumps and blowers and small generators and by means of double helical speed reducing gears to large pumps and blowers, medium sized generators, self-pulleys and slow and moderate-speed machinery.

AIR COMPRESSORS

440. The Denver Rockville Manufacturing Co., Denver, Colorado, 6x9 inch, 16-page bulletin of the Waugh-Sinclair portable compressor plant with the specifications for 32 and 20 HP sizes.

DOUBLEDIMOND STEELKLAD HOUSES

441. This product, manufactured by the Ravenna Steel Co., is standard steel frame made of Doubledimond with metal lath fastened on both sides, producing panels, which are completed at the plant, and all the workmen have to do is to assemble them when the building is ready for plaster and stucco, thus producing a building with a hollow wall all steel and concrete, which is vermin proof, fireproof and frost proof, and very cheap.

UNIONXPANSION JOINT

442. The UnionXpansion joint for concrete roads, manufactured by the Ravenna Steel Co., ties both concrete slabs together in such a way that it prevents raising or lowering of one slab below the other, and still allows for contraction in roads.

JARMIN ROAD FIXER

443. Glide Road Machinery Co., 501 Huron street, S. E., Minneapolis, Minn. Circular describing the Jarmin Road Fixer, an improved machine that has been successfully used in the west to replace graders and drags for maintenance work and for smoothing out waves in highways.

SULLIVAN SPADER

444. Sullivan Machinery Co., 122 South Michigan avenue, Chicago, Ill. Bulletin 70-X, describing the pneumatic clay digging tool for use in ground not hard enough to be blasted and too hard for ordinary pick and shovel work.

SULLIVAN PORTABLE AIR COMPRESSORS

445. Sullivan Machinery Co., Chicago, Bulletin 77-P describing Sullivan Portable Air Compressors WK-31, engine driven; WK-32, driven by electric motor; and WK-34, driven by belt from a tractor, machines that are particularly intended for rock removal in road building or in city streets.

ROAD CONSTRUCTION PROFITS

446. The Blaw-Knox Co., Pittsburgh, 8¼x11½-inch pamphlet listing a diversified line of road building equipment, entitled "Profits on a Road Job Are Regulated by the Time Saved," describes, in a comprehensive manner, the time and money saving attributes of Blaw-Knox central proportioning plants; steel storage bins; adjustable measuring batchers; road forms; truck turntables; subgrade testers; tarpauline carriers; steel forms for roads, streets and sidewalks; and all-steel portable handy houses.

GALION ROAD ROLLERS

447. The Galion Iron Works & Manufacturing Co., Galion, Ohio. 8½x7 inches, 32-page catalog, heavy coated paper, numerous half-tone illustrations, heavy embossed paper covers. Describes motor road rollers and steam road rollers with and without sacrifiers. Gives specifications and lists other road building and maintaining equipment.

RED EDGE STREET SCRAPER

448. The Wyoming Shovel Works, Wyoming, Pa. Illustrated bulletin of special street scrapers for hand work that are fitted with 4-inch chrome nickel blades that are tempered for long service.

SAND AND GRAVEL PUMP

449. Hodge, Thomas & Sheffer, Auburn, Indiana. Circular describing centrifugal pumps for general contractors' service and for handling sand and gravel.

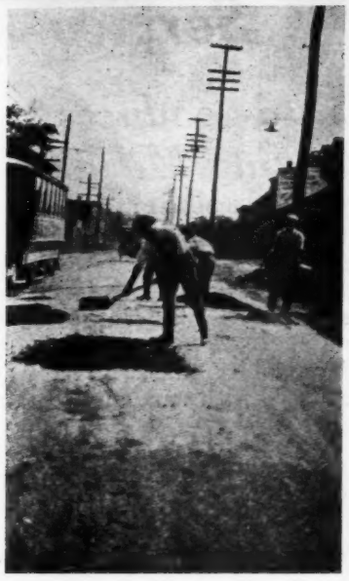
FOUR-WHEEL DRIVE TRUCK

450. Oshkosh Motor Truck Mfg. Co., Oshkosh, Wis. Bulletin with illustrations and specifications for 4-wheel drive truck with capacity of 4,000 pounds pay load, recommended for contractors' purposes and for road building.

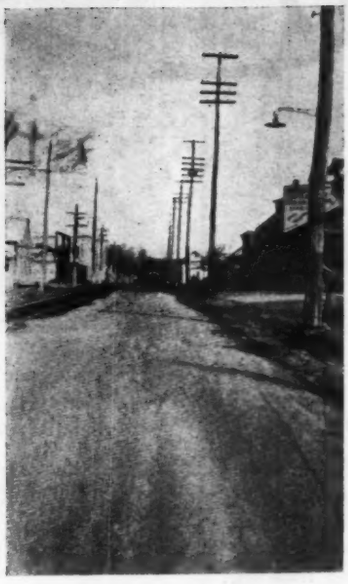
STREET LIGHTING PAMPHLET

451. Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. Reprint of magazine articles entitled, "Street Lighting," "Value of Improved Street Lighting," "Ornamental Street Lighting," "Highway Lighting," "Glassware for Street Lighting," "Transformers, Constant Current Regulations" and "Safety Coils and Auto Current Transformers for Series Lighting Circuits."

COLD PATCH



(1)
Repairing Bituminous Concrete



(2)
Same, two months later, showing repairs after being consolidated by travel

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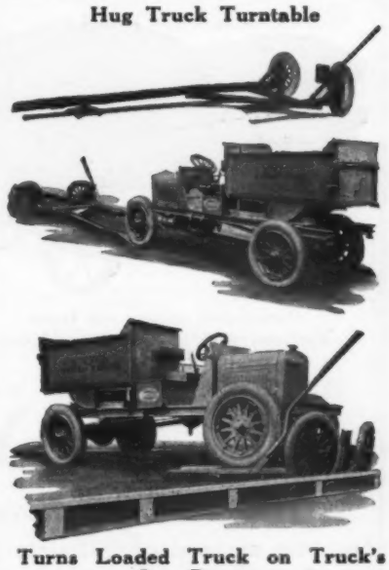
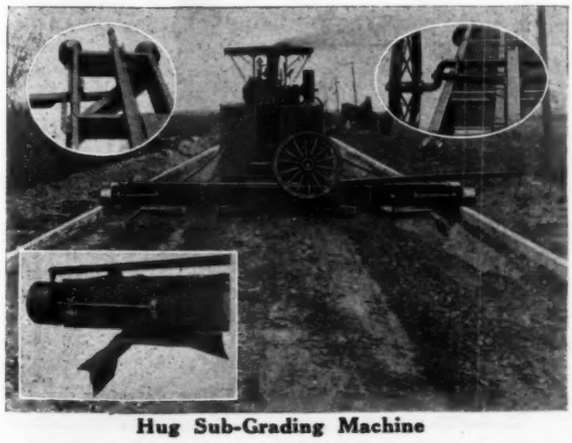
Hug Truck Turntable



Turns Loaded Truck on Truck's Own Power



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The REPUBLIC "THREE" is a small, light mixer for the small builder and cheap enough to enable anyone to own it. The REPUBLIC "SIX" is a medium size outfit, and the REPUBLIC "TEN" a compact sack size machine for general work. These lasting, durable mixers will do your work with the least trouble and expense and at minimum cost for operating and moving.

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Today the most modern and therefore most sanitary method of cleaning streets is by a Vacuum Street Sweeper. This machine sucks up the dirt and dust from all paved streets, not only those with absolutely smooth surfaces, but even cobblestones.

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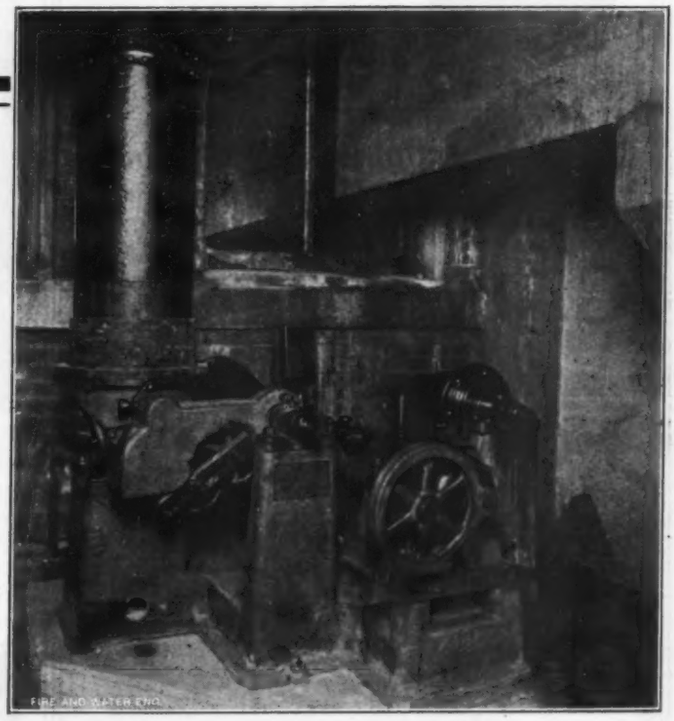

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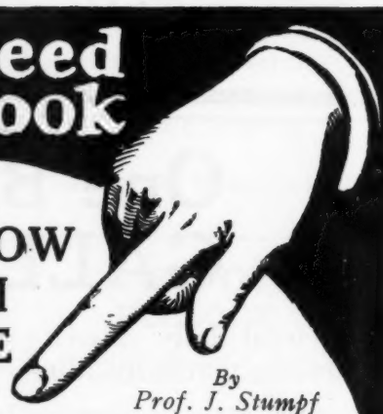

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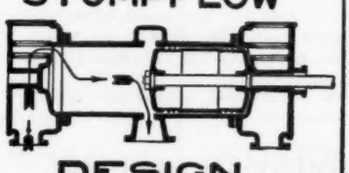

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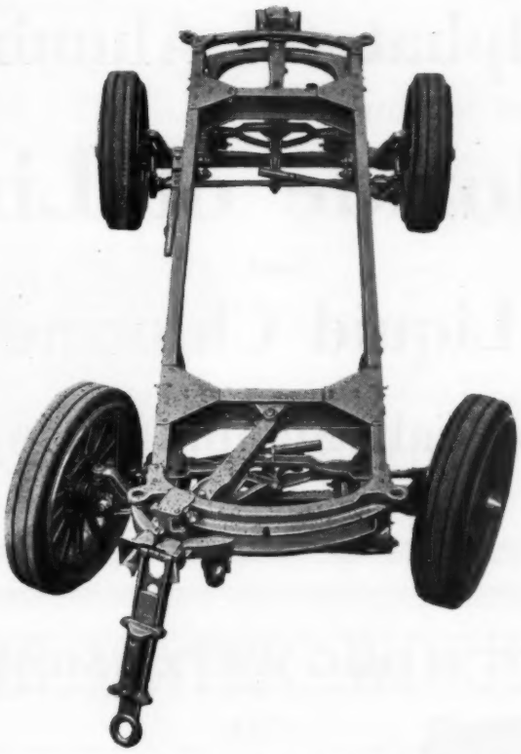
The draw bar is pivoted on the frame, and the pulling stress is transmitted through frame and radius rods to axles, the impulse being equally distributed to all four wheels. If any one wheel drops in a hole or meets an obstruction its radius rod takes the strain.



DETROIT trailer draw head is bell shaped, receiving draw bar pole mechanically and with a positive cam latch which eliminates looseness and assures true alignment. Connection is made instantly with the truck in much the same manner as railway freight cars, no clevis bolts to poke through or cotter pins to bother with. No time lost.

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Steering arm is pivoted on the axle. The relation between the steering arm and steering knuckle is therefore always constant, whereas, when steering arm is pivoted on the frame, the rise and fall due to spring deflection must of necessity disturb the steering control, thus allowing side-sway. The DETROIT steering mechanism compels DETROIT trailers to follow the true line of the truck.

A tie rod independent from the drag link connects knuckle steering arms, thus always keeping the wheels parallel. It is readily understood that where trailer wheels are out of alignment, the tires are soon ground off. Such a vehicle pulls hard, then too, of wrongly aligned wheels whichever one for the instant carries the heavier load, that wheel controls the direction of steering. This is a primary cause of swaying. DETROIT trailers do not sway.

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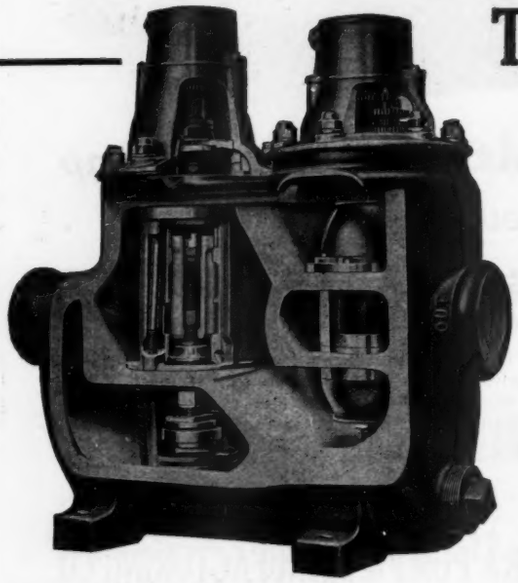

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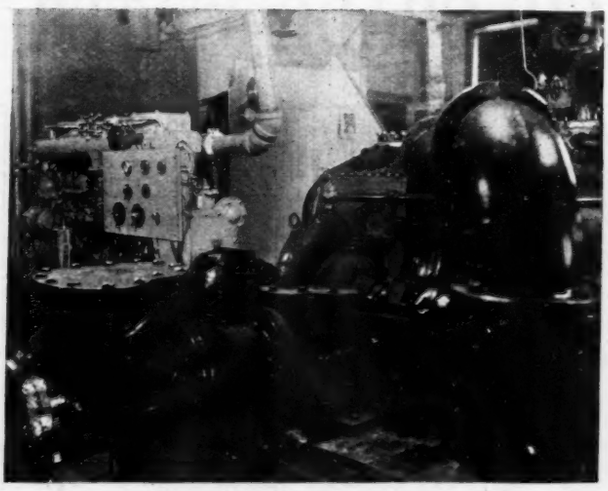

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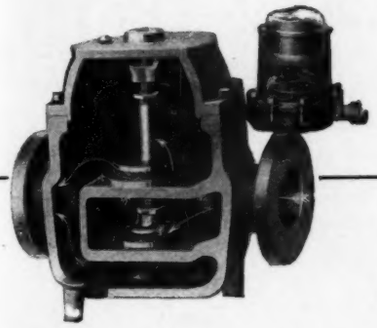

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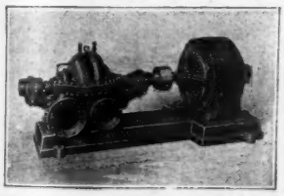

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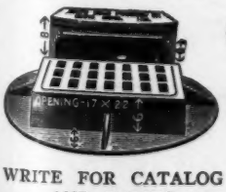

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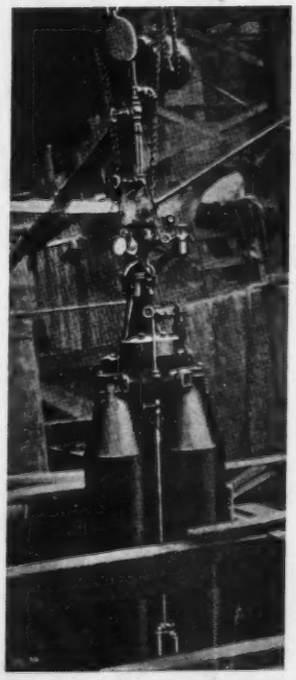

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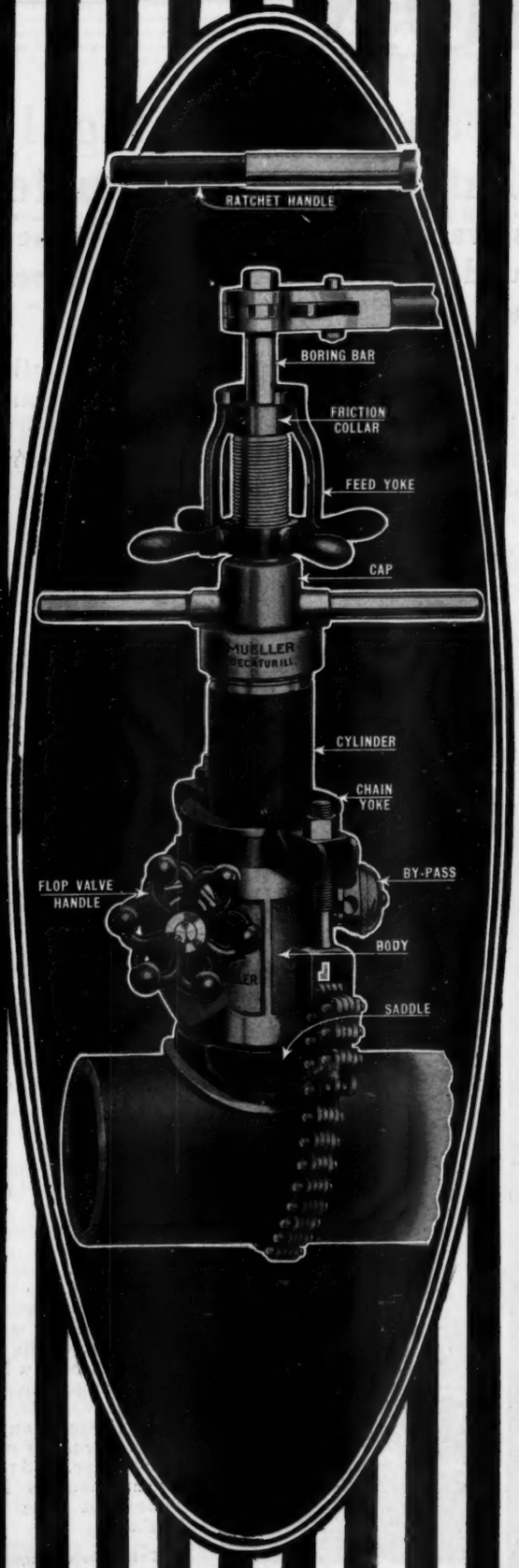

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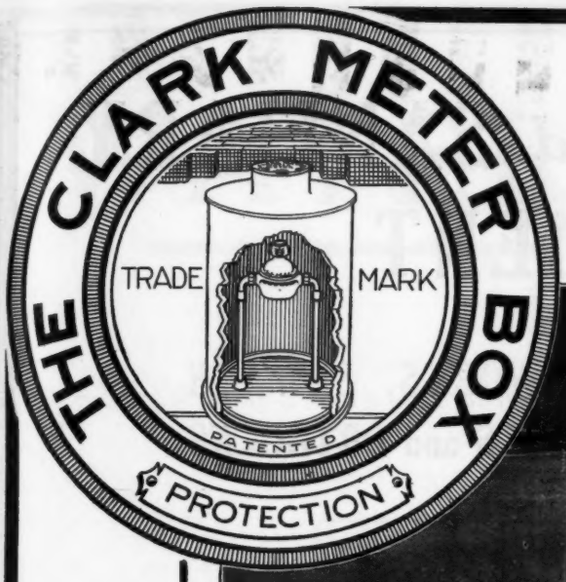

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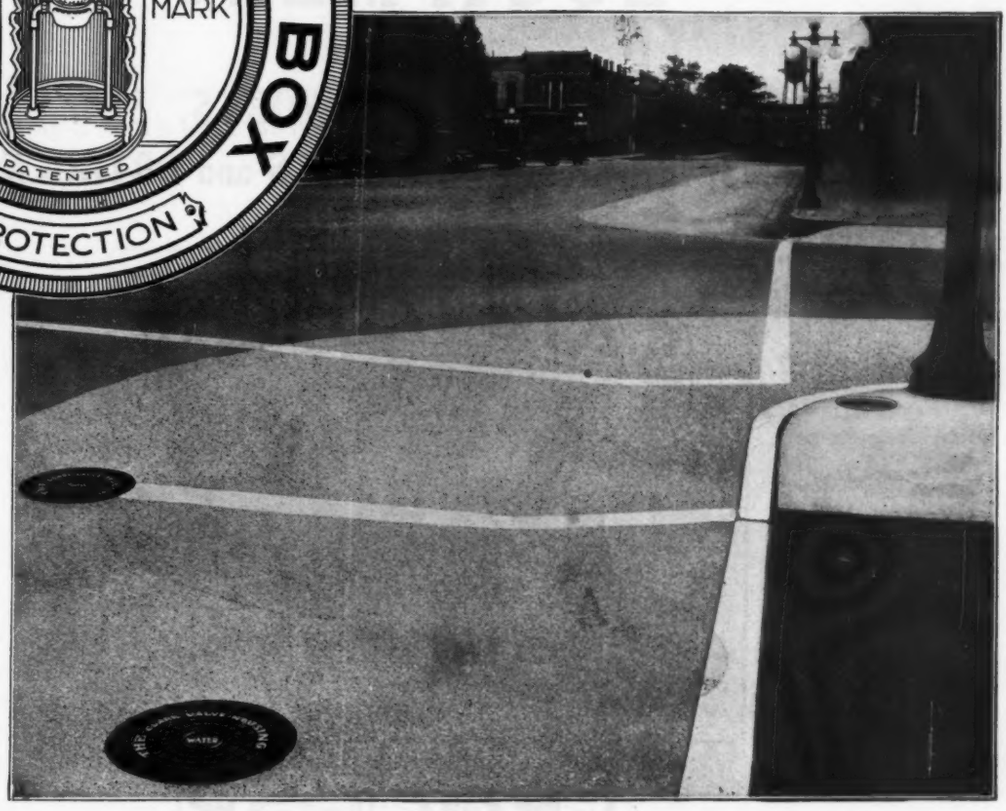

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Fig. 11
Applying
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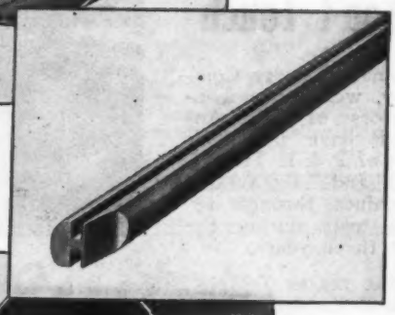
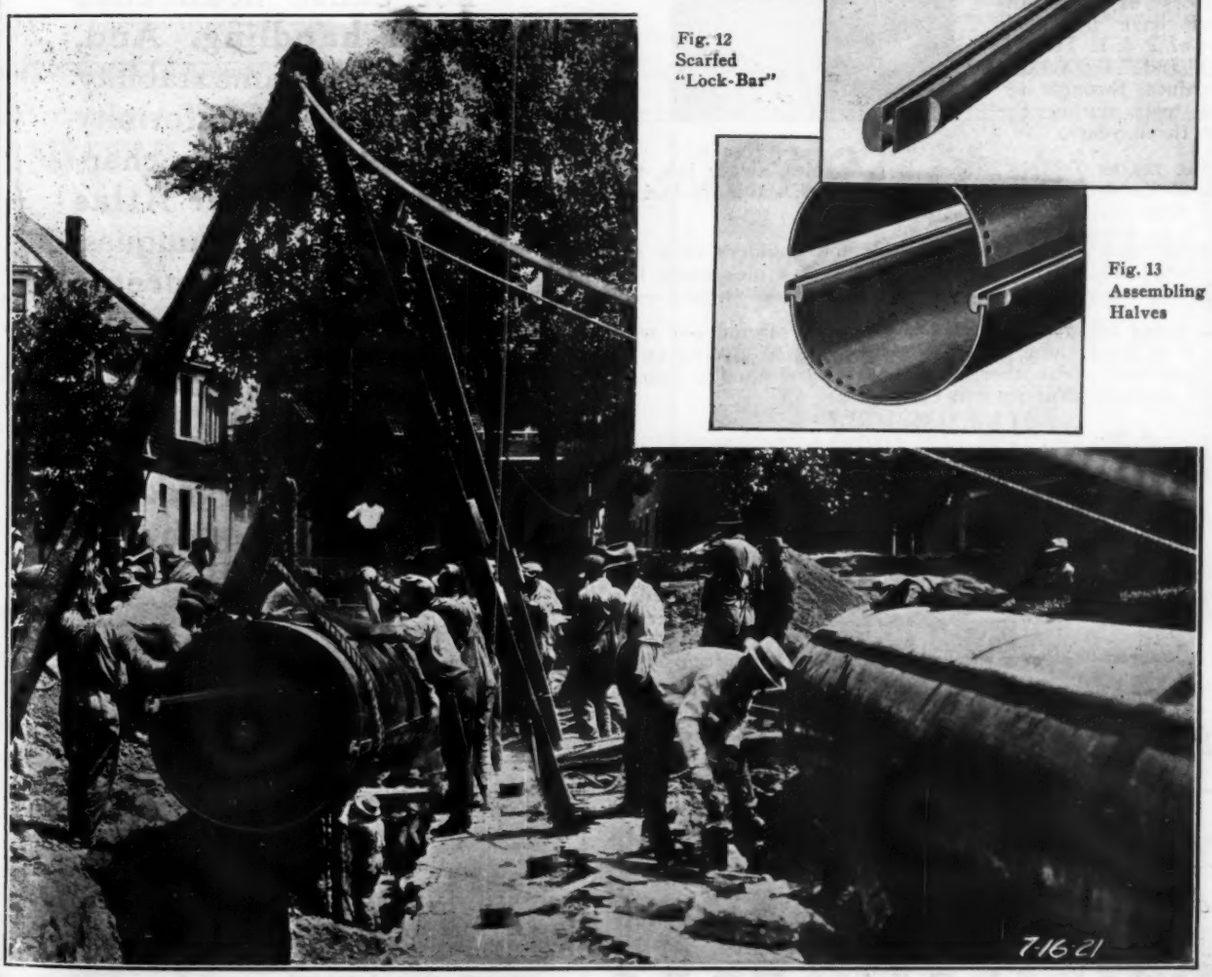


Fig. 12
Scarfed
"Lock-Bar"

Fig. 13
Assembling
Halves



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Steep grades were negotiated, rock and boulders were encountered, and oil macadam so hard that a pick made but little impression.

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A P & H 201 Tom Thumb Backfiller.

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—Byrne, "Highway Construction"

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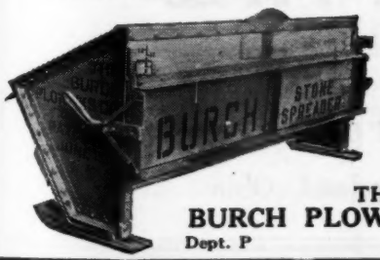
BURCH STONE SPREADER



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SOMEONE must take the initiative in making it possible for people to travel and spend less money—now that there is less money to speed.
So, hand in hand with Hotel McAlpin, which recently announced its reductions, the Martinique—just across the street and under the same management—becomes a leader in lowering hotel tariff.
This is setting an advance style, as it were, for there has not been an appreciable reduction in the cost of running a large New York hotel.
If, however, the public esteems the spirit in which it is done, as much as the management of the McAlpin and Martinique appreciates its patronage, then indeed, is it worth doing.

At the Martinique the new prices are: $3.50 up for room and bath; $2.50 for room without bath.

The
MARTINIQUE

Broadway, at 32nd St., New York

Frank E. Jago, Resident Manager

Road Building and Quarry Equipment

Have established a reputation for continuous SERVICE and Satisfaction

BUILT TO STAND UP UNDER HARDEST WORKING CONDITIONS

RELIANCE EQUIPMENT

Our complete line includes Crushers, Elevators, Screens, Bins, Sweepers, Car Unloaders, Etc.

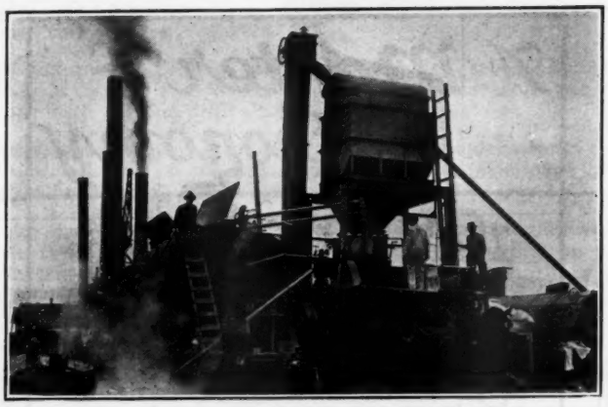
Our Complete Stock Assures Prompt Shipments

Catalogue on request

UNIVERSAL ROAD MACHINERY CO.

114 Liberty St., New York, N. Y. **KINGSTON, N. Y.** **141 Milk St., Boston, Mass**

Manufacturers of the Famous Reliance Line of Road Building, Quarry and Unloading Equipment



ASPHALT PLANTS ALL TYPES

The J. D. Farasey Mfg. Co.

Cleveland, Ohio

H & B PAVING BRICK TESTING MACHINE

Illustration shows N. P. B. M. Standard Rattler for testing of paving brick.

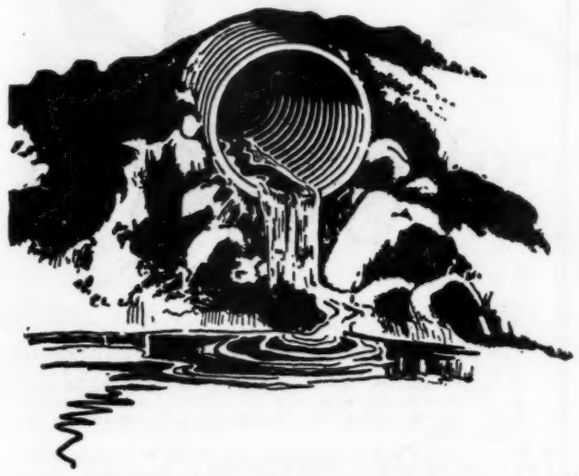
COMBINES ALL THE LATEST IMPROVEMENTS and requirements of construction

Thoroughly tested and tried out for a period of one year under the direction of the technical committee of the National Paving Brick Manufacturers' Association.

Write for descriptive circular and prices.

HETHERINGTON & BERNER

INDIANAPOLIS, INDIANA



Quality in Every Inch of Newport Culverts

When you buy Newport Culverts you are sure of getting the best material available.

Every Newport Culvert is made of

"Genuine Open Hearth Iron"—99.875 per cent pure iron-copper alloy, 0.25 per cent copper, with 2 ounces of spelter per square foot.

They are carrying water under highways, over which heavily loaded motor trucks by the thousand pass. They are strong, rustless, easy to put in, and the moderate first cost is the only cost.

When in the market for culverts think of NEWPORT.

100% QUALITY

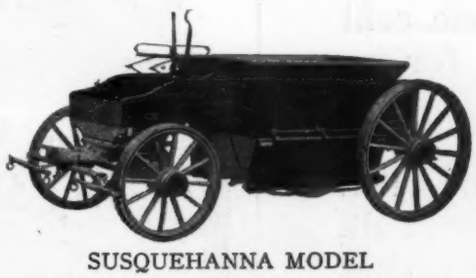
Send for our catalogue.
A post-card will bring it.

NEWPORT CULVERT COMPANY, Inc.
533 West Tenth Street Newport, Kentucky

100% QUALITY

An Exceptionally Sturdy AUTOMATIC DUMP WAGON FOR CONTRACTORS

STRONG AND WELL DESIGNED



SUSQUEHANNA MODEL

FROM 1½ TO 3 YARDS CAPACITY

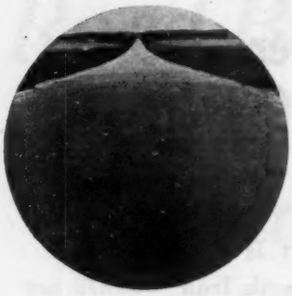
In closing the bottom doors, one side always shuts first, making a dirt-tight joint.

Its light draft, large wheels and short turning radius, make it unusually desirable for road work.

Send for descriptive literature and prices

The Columbia Wagon and Body Co.
Columbia, Pa.

We build the Jennings Automatic Dump Body for Ford ton and other makes of ton trucks



right to

the Point

WOULDN'T you consider it a good investment—money well spent, if you were to build a road which after seven years service was in as good condition as the day it was completed?

The asphalt macadam road illustrated above was built during 1915 of

STANOLIND PAVING ASPHALT "C"

(Penetration Method)

and to date not one cent has been required for repairs.

Send for our booklet, Stanolind Paving Asphalt. It tells all about the proper construction of asphalt roadways.

STANDARD OIL COMPANY

(INDIANA)

910 S. Michigan Ave. Chicago, Illinois

THE HONHORST
Tar and Asphalt Heaters

Write for Description **TAR WAGON** *Prices and Pamphlet*

This heating kettle, called a Tar Wagon or Four-Wheeled Kettle, meets the demand for a high grade portable kettle of large capacity, for transporting, melting, heating, boiling down or reducing any kind of oil, tar, pitch, asphalt, joint filler, roofing composition, bituminizing materials, or patented paving filler.

The kettle is semi-cylindrical, and made of ¼-inch boiler steel throughout, strongly braced with heavy angle iron. The firebox will burn any kind of fuel. Running gear, axles and wheels are the very best made, no expense being spared in perfecting them.

250, 350, 500, 700, 900 Gallon Capacities

WE MANUFACTURE

Steel Smokestacks	Tool Heaters
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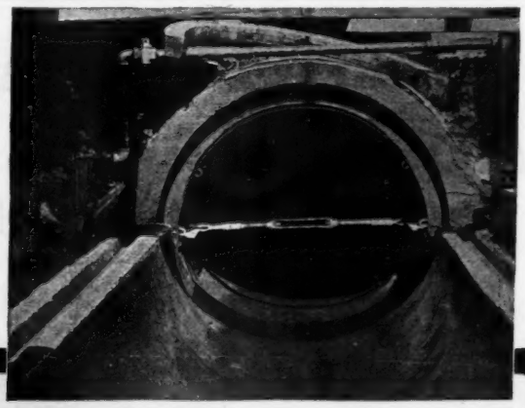
Steel Hoppers	Steel Lathe Pans

THE JOS. HONHORST CO.

CINCINNATI 1016 W. SIXTH STREET OHIO



Blaw Sewer Forms
Any Size-Any Shape

Consider the cost of lumber; the expensive expert labor required to build and knock down the forms and the large pile of almost useless lumber on your hands when the job is finished—and compare the appearances of a wood form and a steel form built sewer.

Blaw Sewer Forms are labor savers, time savers and money savers—they will build real sewers.

Blaw Sewer Forms of standard sizes and shapes are carried in stock—and leased to you. Sewers of especially large size or odd design require special forms, which we will design and build to suit your needs.

Submit your proposition to us for an estimate—write us.

BLAW KNOX COMPANY

PITTSBURGH, PA. 6..1 Farmers Bank Bldg.

NEW YORK-BOSTON-CHICAGO DETROIT-SAN FRANCISCO

Everything for Concrete Roads

Truscon Road Products are broad in scope. They include Wire Mesh in flat sheets for reinforcing concrete roads; Curb Bars for protecting edges of concrete pavements; and Contraction Joints to take care of the contraction in such roads. All Truscon materials are of the highest quality, and embody the results of years of experience in highway work.

Truscon Wire Mesh in Flat Sheets

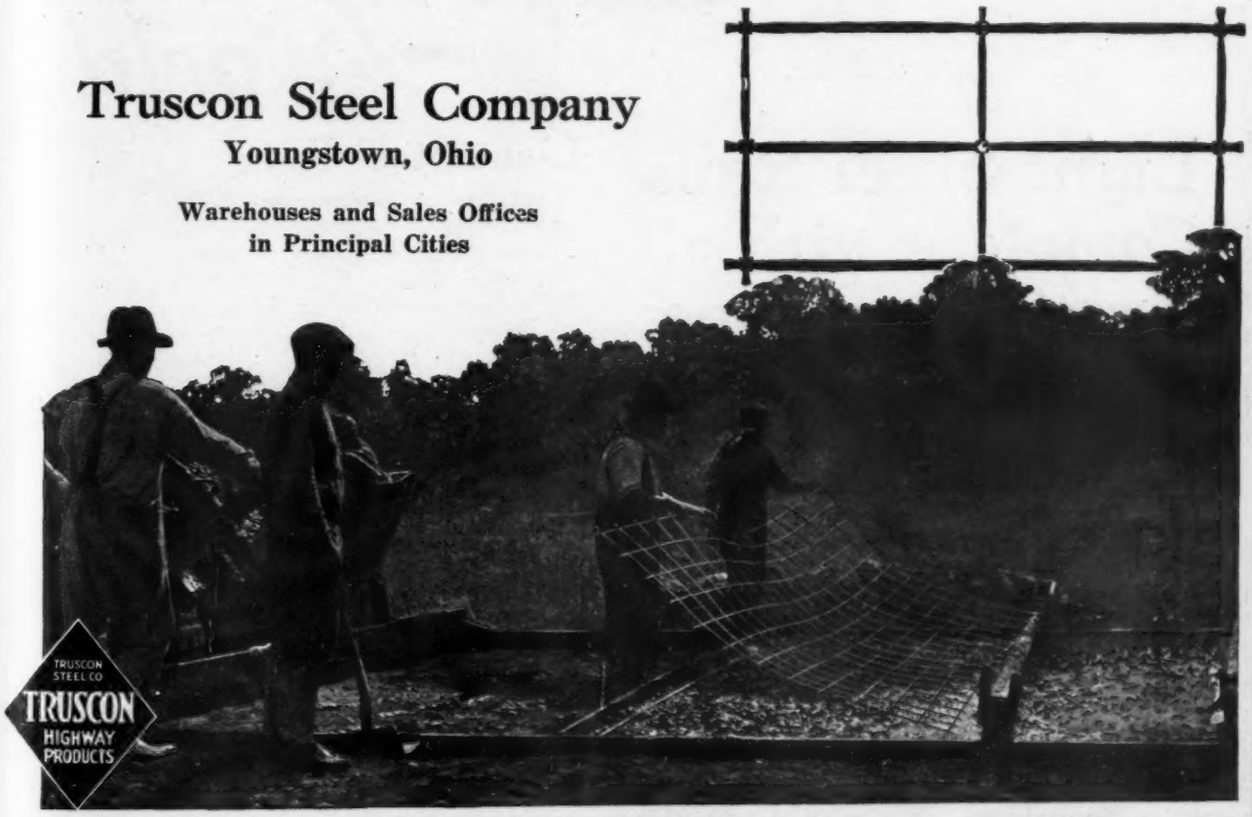
A superior reinforcement, furnished in flat sheets cut to any desired length. Many state highway engineers specify flat sheets exclusively for their road work, as it has been convincingly demonstrated that this means more mileage and better roads, with lower costs and less labor. Truscon Staple Joints make the connection absolutely rigid, and guarantee the sheet to remain in perfect form during all necessary handling. Get our estimates.

Truscon Curb Bars Protect Concrete Edges

Manufactured under powerful machinery from special steel sections, Truscon Curb Bars are designed to give ample protection without waste of material. Positive anchorage, rigidity and convenient size make Truscon Curb Bars easy to handle and install, and effective in actual use. Furnished either straight or curved; standard lengths 6, 8, 10 and 12 feet.

Truscon Steel Company
Youngstown, Ohio

Warehouses and Sales Offices in Principal Cities



SWEET'S

The STANDARD of the World

Light Steel Rails
Complete with all necessary accessories for Permanent or Portable Track

Light Steel Rails
Portable or permanent track

Standard A. S. C. E. Rail Sections, weighing from 8 to 60 lb. per yard with a complete line of accessories—for either temporary or permanent track. The dependable uniformity—the absence of all pipes or flaws in all Sweet's Steel Rails is saving money for concerns in every branch of industry. The name "Sweet's" is the mark of long life, under the hardest service.

We are prepared to furnish standard and special Plain Splice and Angle Bars in any quantities for Rail Sections 8 lb. to 60 lb. per yard. Our business on Splice Bars alone has grown to such an extent that we can now justly be classed as the largest independent manufacturers of this product.

STANDARD STEEL SPIKES AND OVAL NECK TRACK BOLTS

These also play an important part in completing our line of Track Equipment. Your requirements can be supplied, regardless of quantities, in a quality and at an attractive price at all times.

SWEET'S STEEL COMPANY

3100 Sweet Street **Williamsport, Pa.**

TRADE MARK
Kinney
REG. U.S. PAT. OFF.

ROAD PLANER

Especially designed for use on bituminous roads and highways. For planing or leveling the waves or ridge elevations that frequently appear on the road surface; without destroying the contour of the roads. May also be used to good advantage on macadamized or dirt roads.

Write for full particulars.

KINNEY MANUFACTURING COMPANY
BOSTON, MASS.
Branches in all the principal cities.

THE PAINT FOR LONG SERVICE

The paint that will give the most years' protection is the one that it pays to use.

DIXON'S
SILICA-GRAPHITE
PAINT

because of its pigment, flake silica-graphite, and vehicle, best linseed oil, has that quality of long life. It will not peel, crack or flake off because of the natural elasticity of the flake graphite.

Dixon's Paint is made in FIRST QUALITY only and we have many records of long service in various industrial lines.

Write for Booklet No. 102-B and records of long service in your line.

Made in JERSEY CITY, N. J., by the
JOSEPH DIXON CRUCIBLE COMPANY
JERSEY CITY NEW JERSEY

Established 1827

1/3 more per dollar

The excerpt below is from a letter written by a user of Dumorite for contracting operations.

"I am in receipt of yours of the 8th inst., asking my experience with your Dumorite dynamite, and beg to advise that I have been using it now for the past sixty days in hard limestone rock and find that it does all that you claim for it.

"My foremen claim that they get better results from the same number of sticks of Dumorite than they do from 40%——, and in addition to that, it has the advantage of not freezing. Since using it, I have heard no complaints from headache.

"I prefer a bulky dynamite like Dumorite, as it seems to go farther with equally good results."

O. K.d by the Severest Judges

NO ONE is better fitted to judge the value of an explosive than the contractors who shoot it.

We have stated that Dumorite does the work of 40% dynamite, stick for stick. Above is an excerpt from one of many letters from contractors testifying to this fact.

Remember that Dumorite gives you 35 to 40 sticks per case more than 40%, at the same price. Get in touch with our nearest branch and let Dumorite save money for you, too.

Address our nearest branch office for full information

E. I. du Pont de Nemours & Co., Inc.
Explosives Department
Wilmington, Delaware

Branch Offices

Birmingham . Ala.	Huntington, W. Va.	St. Louis . . Mo.
Boston . . Mass.	Kansas City . Mo.	Springfield . . Ill.
Buffalo . . N. Y.	New York . N. Y.	San Francisco, Calif.
Chicago . . . Ill.	Pittsburgh . . Pa.	Scranton . . . Pa.
Denver . . Colo.	Portland . . Ore.	Seattle . . Wash.
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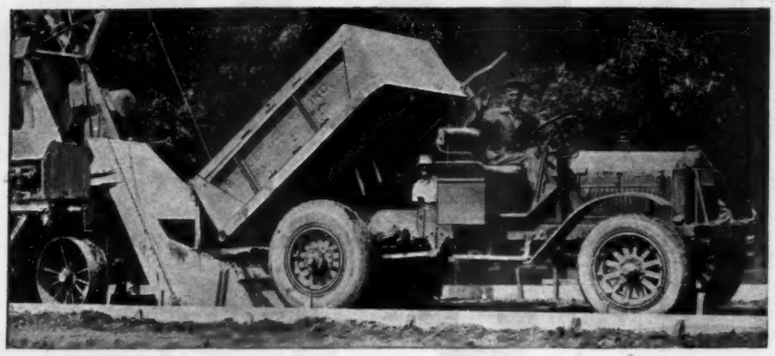
Du Pont Products Exhibit
Atlantic City, N. J.

NON-HEADACHE DU PONT NON-FREEZING
DUMORITE
THE LATEST OF A COMPLETE LINE OF DU PONT EXPLOSIVES



The 2½-ton Truck with a two Batch Body shown at the left is one of the 41 Trucks equipped with Heil Bodies and Hoists used during the season of 1921 by the Wisconsin Service Company of Milwaukee. Mr. Henry Nickels, Jr., writes the Heil Co. that this equipment is standard with them because it means time saved, plus money earned and gives a total of satisfaction.

FOR ROAD BUILDING and Construction Work

The cost per square yard of finished road or other concrete construction is largely affected by the cost of handling the materials.

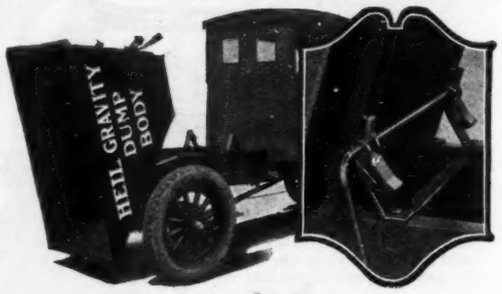
Heil Bodies and Hoists cut these costs. They are available in various types for handling loose materials and mixed concrete and asphalt. They can be mounted on any chassis, old or new. Write for the Heil catalog of Dump Bodies and Hoists. It will help you select the proper equipment for your work.

THE HEIL CO.

1132-50 Montana Ave. Milwaukee, Wis.

Distributors: New York City, Chicago, San Francisco, Pittsburg, Cleveland, Washington, St. Paul, Richmond

Gravity Bodies for Alley Paving



Easy to Mount, substantial, water-tight construction.
Price, 1 yd. Body, $100.00
Write for Bulletin 128-E

O. S. DEPENDABLE

LOCOMOTIVE CRANES CLAM SHELL and ORANGE PEEL BUCKETS

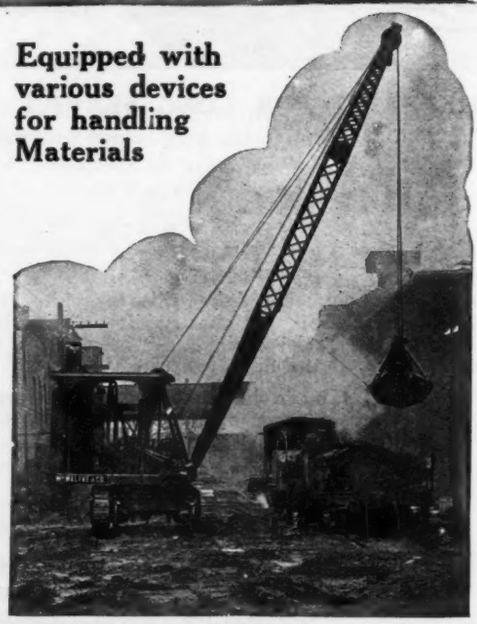
O. S. DEPENDABLE CRANES possess almost unlimited mobility. The radius of operation and variety of uses make them economical in road construction and excavation work. They mount obstacles, travel through the mud, turn in a 15-foot radius and have proved their excellence through years of satisfactory service. For speed, capacity and service they are unequalled.

Write us outlining your field of work and we will submit prices. Catalog No. 18 mailed upon application.

ORTON & STEINBRENNER COMPANY

Main Office: Chicago, Ill. Factory: Huntington, Ind.

Equipped with various devices for handling Materials



TIFFIN STREET FLUSHERS
TIFFIN STREET SPRINKLERS

have those characteristics of design, construction and equipment that stand for

SERVICE, EFFICIENCY AND ECONOMY

We specialize in Municipal Equipment and for that reason are always in position to give you Superior Service.

Tell us of your requirements and let us help you solve your late summer problems, by early shipment of one of these wonderful machines at our new prices.

The TIFFIN WAGON CO., *Tiffin, Ohio*

ALSO BUILDERS OF MOTOR TRUCKS, DUMP WAGONS, GARBAGE WAGONS AND FARM WAGONS

You'll Have To Admit This Is Some Smooth Ditch-Deep Too!

The picture shows the excellent road work accomplished with Russell Road Machines—taken in Travis County, Texas—and Texans know that their road problems demand unusual efficiency. Here "Russells" lead as they do in other states—easily the most numerous and doing the best work.

Russell Equipment covers everything needed for road construction, road maintenance and road repairing including Road Drags, Dump Wagons, Culverts, Steel Beam Bridges, etc.

A very complete catalog for Road Builders sent free.

RUSSELL GRADER MANUFACTURING CO.
FACTORY AND GENERAL OFFICES—MINNEAPOLIS, MINN.
Affiliated Plants—Cicero, Ill., North Kansas City, Mo., Memphis, Tenn., Dallas, Tex.

RUSSELL
ROAD EQUIPMENT

How Many Times Do You Pay for Your Roads?

First costs vary—but not as much as upkeep—and it is the upkeep that tells in the end. Often upkeep means paying more for roads after they are down than it originally costs to lay them.

Warrenite-Bitulithic Pavement

because of its superior construction and close inspection is distinguished in comparison with other pavements by the surprisingly low cost of upkeep. All over the United States and Canada, in the face of every conceivable climatic condition, and under all sorts of traffic, this pavement is establishing new records for efficient, economical service.

An interesting booklet concerning this pavement and its performance will be sent to interested parties on request.

Warren Brothers Company

Executive Offices:
Bowdoin Square, Boston, Mass.

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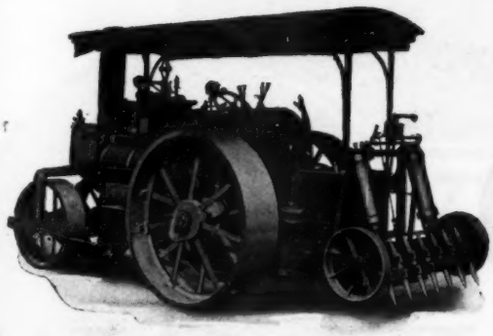
ACME

Equipment

Will Reduce Your Operating Costs

Its reliability enables you to complete your contract on time



4 CYLINDER MOTOR ROLLER

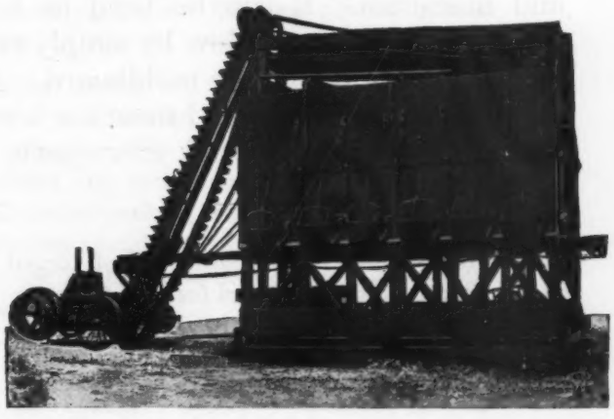
Find out about the full line of Acme Road Building Machinery.

We manufacture: Acme Four-Cylinder Motor Road Roller; Rock Crushers—Solid Cast-Steel Frame Portable and Stationary; Elevators, Screens, Portable Storage Bins; Tom Thumb Graders, Patrol to Traction; Portable Gravel Screening and Unloading Plants; Wagons, etc., Steam Road Rollers.

WRITE FOR CATALOGUE

ROAD GRADERS

BOTTOM DUMP WAGON



MTD. FULL PORTABLE CRUSHING AND SCREENING PLANT

ACME ROAD MACHINERY CO.

FRANKFORT, N. Y.

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EXPORT OFFICE: 120 Liberty Street, New York City
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Provident Bank Building, CINCINNATI, OHIO
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CHOCTAW ROAD SUPPLY CO., Memphis, Tenn.
PHILIP GROSS HARDWARE & SUPPLY CO., Milwaukee, Wis.
CLYDE EQUIPMENT CO., Portland, Oregon
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PAT'D. JUNE 25. 1907
WIARD PLOW CO. BATAVIA, N.Y. U.S.A.
ALL STEEL
WIARD STEEL CONTRACTORS PLOW NO. 69
WHEN USED AS A ROOTER PLOW REMOVE THIS WING
J. Kampel

WIARD

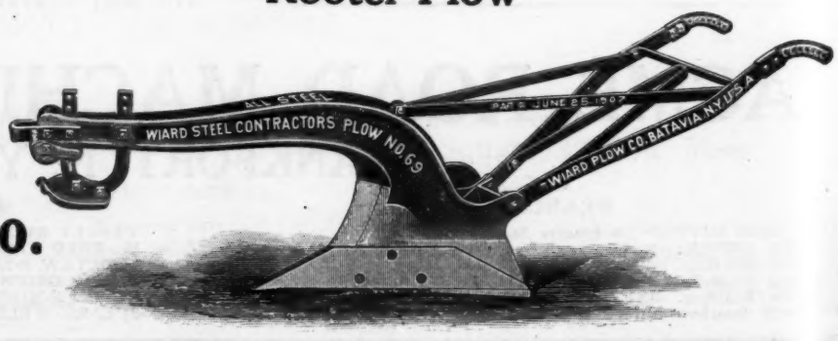
Two in one PLOW

This plow has great strength and is adapted to contractors' work—for tearing up cobblestones and macadam. It can be used as a perfect rooter and pavement plow by simply removing the steel wing below the moldboard. Answers any and all purposes, and means a less investment and keeping in stock extra parts for one plow only.

The point is made from a solid bar of forged steel. It can be reversed end for end, thus giving double wear. The beam is one solid piece of cast steel. We make a full line of plows for every requirement.

Write for descriptive literature.

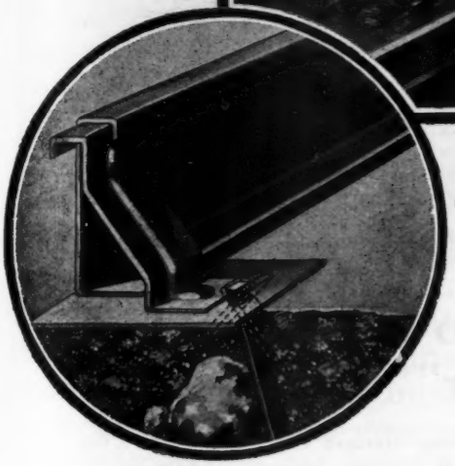
used as a Rooter Plow



No. 69 (All Steel) Contractors' Plow, Landside View

Wiard Plow Co.

Batavia, N. Y.



Drive a Heltzel Stake Where You Want It

SET the pedestals and merely hang the rails—you needn't worry about the obstructions underneath the subgrade.

For you can drive a Heltzel stake at any angle you choose—right, left, out, or in and they hold rail and pedestal rigid—because Heltzel stakes are flat and cannot turn or twist.

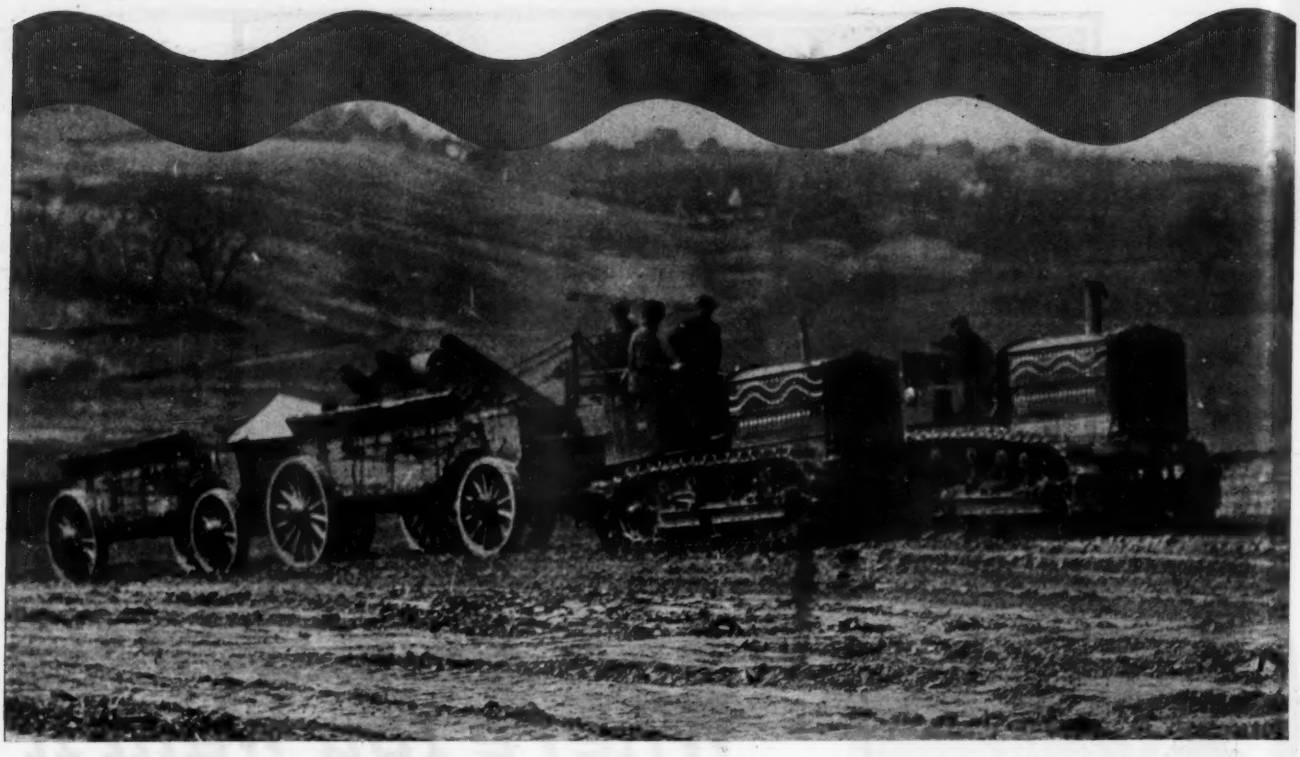
Heltzel forms are built like a railroad—a rail, a pedestal and a stake—no keys, wedges or clamps. No right or left hand rails. Heltzel rail and pedestal fit together snug and secure making a perfect joint and guaranteeing certain and sure alignment. Write for the Heltzel Blue Book which gives complete details.

THE HELTZEL STEEL FORM & IRON CO., Warren, Ohio

Largest exclusive builders of steel forms for Road, Sidewalk, Curb, Curb and Gutter and all types of concrete construction and Tamping Machines, Heltzel Hand Strikeoff Tamp, Heltzel Rotary Steel Float, and other accessories.

HELTZEL STEEL FORMS

BUILT LIKE A RAILROAD



There Is No Substitute for "Caterpillar"* Experience

The "Caterpillar's" field of usefulness is by no means limited to road making. There is a "Caterpillar"* of size and capacity for every power need. On farm or ranch, in the mining, oil and lumber industries, for snow removal and other civic work—wherever power and endurance are at a premium, the "Caterpillar"* has no real competitor.*

Holt has pioneered in building tractors for many years. Our engineers have kept in close contact with the conditions encountered by highway officials and contractors on their road making, dirt moving and hauling jobs in every part of the world. This first-hand engineering experience, combined with our unequaled production facilities, has made the "Caterpillar"* the standard tractor the world over. "Caterpillars"* will master the toughest going and operate continuously and profitably where no other method or machine can work at all. Their power and endurance means that the job will be done in less time, with fewer men, and at the lowest cost. Other tractors, even some that superficially look like the "Caterpillar"*, may be bought at a lower price, but experienced users will tell you that on the basis of cost per horse-power per year the "Caterpillar"* is actually the *cheapest buy on the market.* Send for a copy of our booklet, "Caterpillar* Performance."

CATERPILLAR
Reg. U.S. Pat. Off.
HOLT
PEORIA, ILL.
STOCKTON, CALIF.

**There is but one "Caterpillar"—Holt builds it. The name was originated by this Company, and is our exclusive trade-mark registered in the U. S. Patent Office and in practically every country of the world.*

THE HOLT MANUFACTURING CO., *Inc.*, PEORIA, ILL.

Branches and service stations all over the world

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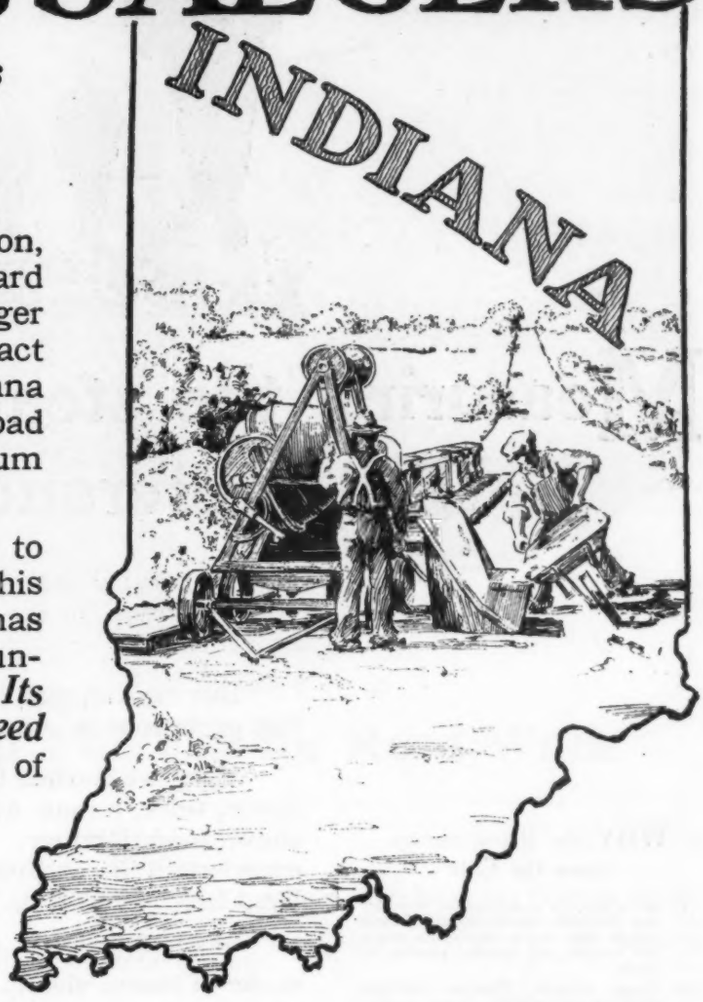
116 S. Michigan Ave., Chicago, Ill.
Holt Company of Texas, Dallas, Texas
Canadian Holt Company, Ltd., Montreal, P. Q., Canada

Another State Chooses JAEGERS

Hoosier Commissioners Select Jaeger Mixers Over All Competitors

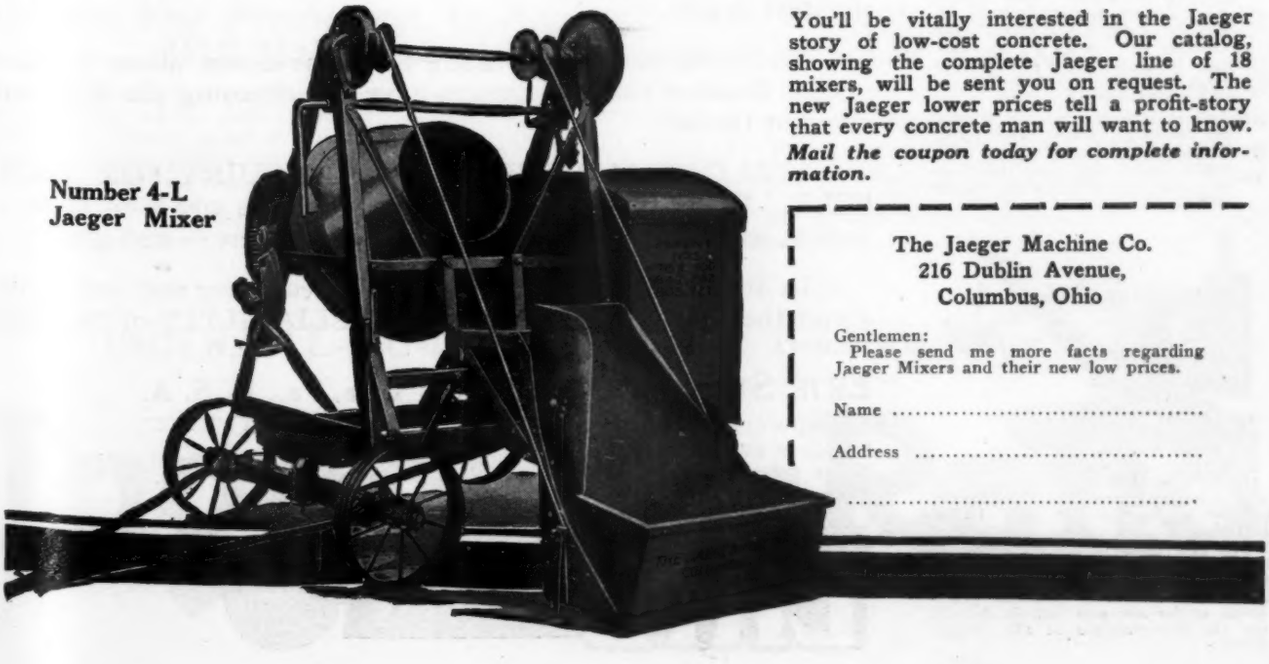
IN an "open field" competition, with practically every standard make of mixer represented, Jaeger was recently awarded the contract for supplying the State of Indiana with Jaeger Mixers for their road work — 20 Jaeger Tilting-Drum Outfits.

Indiana is not the first state to standardize on Jaeger Mixers. This sturdy, tilting-drum machine has become the leading mixer in hundreds of sections everywhere. ***Its low first cost, low upkeep and speed of mix*** have made it the choice of 13,000 contractors and builders.



The Jaeger Machine Company

400 Dublin Avenue Columbus, Ohio



Number 4-L Jaeger Mixer

You'll be vitally interested in the Jaeger story of low-cost concrete. Our catalog, showing the complete Jaeger line of 18 mixers, will be sent you on request. The new Jaeger lower prices tell a profit-story that every concrete man will want to know. ***Mail the coupon today for complete information.***

The Jaeger Machine Co.
216 Dublin Avenue,
Columbus, Ohio

Gentlemen:
Please send me more facts regarding Jaeger Mixers and their new low prices.

Name .....

Address .....

.....

Measuring the steam shovel owner's preference for the ERIE

You know — and almost everybody else knows — which revolving shovel in the ¾ cu. yd. class is preferred by most steam shovel owners.

But we did not have any exact measure of just how strong this preference is — not until a few weeks ago.

Then we learned the facts from a leading authority on steam shovel work, a man who is not connected in any way with any shovel manufacturer. He had sent out 500 letters to companies experienced in excavation, asking which revolving shovel they liked best — and *why*.

This letter of inquiry was absolutely impartial. No particular make of steam shovel was mentioned, or even hinted at, in the slightest degree.

The preference for the ERIE Shovel is shown above in exact scale. Reasons that the owners gave for choosing the ERIE are given at the left.

YOU CAN MAKE THIS SAME INQUIRY FOR YOURSELF. Every time you meet a man who does any kind of excavating, ask him which steam shovel he likes best — and *why*.

In answer to this question you will hear, over and over again, about the remarkable SPEED and RELIABILITY of the ERIE.

WHY the shovel owners chose the ERIE

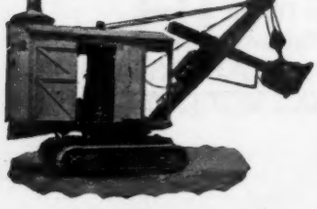
(1) More durable and reliable; stronger and simpler construction. Lower repair cost—more reasonable prices for repairs and quicker service on parts.

(2) Larger output. Quicker working motions and simple 3-lever control give unequalled speed. Steady reliability of the ERIE means more yardage.

(3) Easy to move—the ERIE'S *lubricated* caterpillar type mounting the most satisfactory ever used.

(4) Good investment. More real value for the money; higher resale value.

(5) All-around usefulness—every "B" ERIE Shovel can be used as Crane to handle clamshell bucket, orange-peel or dragline.



If the 1,900 ERIE Shovels now in service have won such favor—what will be the opinion of the new 1922-23 ERIE?

The new machine has 32 important improvements, adding greatly to its efficiency. It is a far better "buy" than any ERIE Shovel of previous years. *Write us for our new bulletin describing the improvements in the* 1922-23 *ERIE.*

ERIE STEAM SHOVEL CO., Erie, Pa., U. S. A.

Incorporated 1883, Formerly BALL ENGINE CO.

Builders of ERIE Steam Shovels, Locomotive Cranes, Railway Ditchers.

Branch Offices: Boston, New York, Philadelphia, Pittsburgh, Chicago.

Representatives throughout the U. S. A.

ERIE Revolving Shovels

What Compressor Will You Use for Road Work

Are you expending time and money to erect a stationary air compressor plant with all of its accessories, foundation and housing, every time you need air?

Are you going to haul coal or other bulky fuel over rough roads and pipe up a cooling water supply to keep this compressor running?

And as the work progresses and the "Jackhamer" drills keep getting further away from the compressor will you keep adding another section of air pipe or hose? If so, how about the loss of power due to friction and possible leakage?

After the job is finished are you going to dismantle the plant, tear down the shack, load it on trucks to be carried to the next location—where you will have to erect it again?

Or, Are You Purchasing An Ingersoll-Rand Portable Compressor Which Will Make Your Air When and Where You Want It?

These portable compressors are self-contained, complete and ready for work. The compressor, gasoline engine (or electric motor), receiver, fuel tank, cooling water system and other accessories are all mounted on a covered steel frame on wheels.

All you have to do is to connect up the "Jackhamer" drills, crank the engine, and you are ready for work. As for moving to the next job—it is only a matter of hitching up the horses or arranging for truck haulage.

Gasoline Engine Driven Portable Compressors—45, 118 and 210 cu. ft. capacity
Electric Motor Driven Portable Compressors—45 and 118 cu. ft. capacity

Send for bulletins 3315, 1062 and 1107; also our booklet entitled—"Compressed Air for the Roadbuilder."

INGERSOLL-RAND COMPANY, 11 Broadway, New York

Offices in all principal domestic and foreign cities.

651-C

Ingersoll-Rand

TRADE MARK Kinney REG. U.S. PAT. OFF.

PATENT COMBINATION AUTO HEATER AND DISTRIBUTOR

Every Road Builder, Contractor and all others who wish to save time, labor and money will do well to investigate the Kinney Auto Heater and Distributor.

It has stood the test of time and is used extensively throughout the United States and Canada.

When not required for road oiling the tank and entire oiling attachment can be removed, and the truck used for other purposes.

For heating and applying under Pressure all varieties of Bituminous Materials, Hot or Cold, for Road construction Maintenance or Dust Laying.

Heat and volume under instant control of operator. Positive pressure produced by the Kinney Pump.

PERFECT APPLICATION

TRADE MARK Kinney REG. U.S. PAT. OFF.

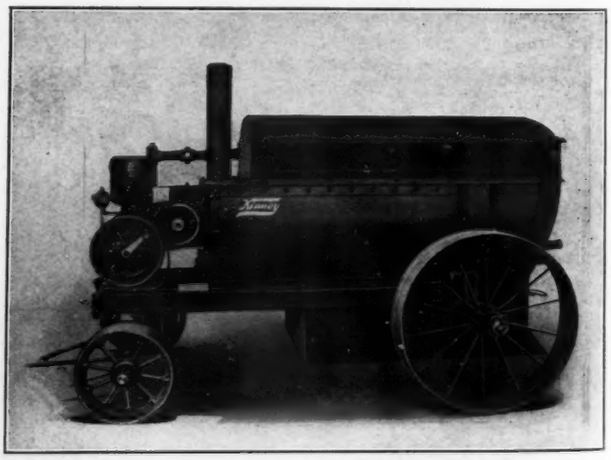
HANDY HEATER AND SPRAYER

ESPECIALLY ADAPTED FOR ROAD MAINTENANCE CONSTRUCTION AND GENERAL REPAIR WORK

Contents thoroughly agitated while heating.

No burning or coking of material. Pump, Piping, Hose, Nozzles, Automatically Heated.

No Steam Required.



Kinney Manufacturing Company

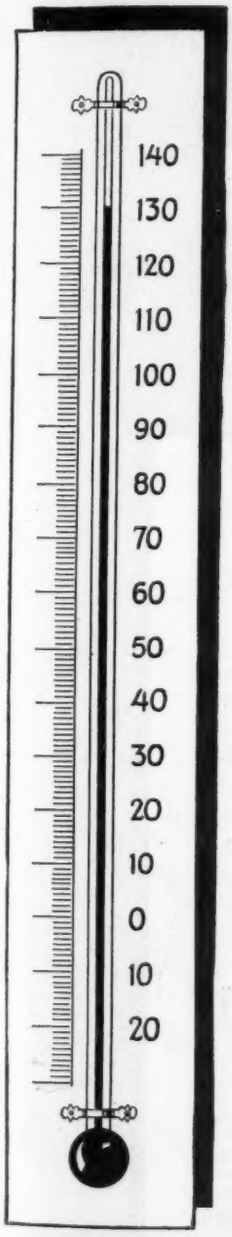
BOSTON, MASS.

New York Philadelphia Chicago Houston Kansas City San Francisco
Philippine Islands Porto Rico Cuba Hawaiian Islands

Carey Elastite

TRADE MARK REG. U.S. Pat. Office

PROVED AND ACCEPTED EXPANSION JOINT



Every 100 yards of concrete expands 2½ inches for each 100 degrees of increased temperature. Elastite absorbs this strain.

The "safety-factor" you can't neglect *in* road building

ELASTITE has been proved by years of use to be the important safety-factor in concrete road construction, protecting the surface from disruption caused by expansion due to temperature changes.

Elastite takes up the stress of expansion without squeezing out of the joint, its tempered asphalt base being highly compressible in its own volume. No ordinary asphalt joint will do this effectively.

Elastite tempering also makes a long-wearing joint; and its felt walls prevent the joint from sticking together and give it necessary stiffness for easy handling.

Use Elastite in concrete, brick and block paving, concrete buildings, sidewalks, and wherever protection against expansion and contraction is necessary.

Immediate shipments in any quantity from large stocks at seventeen convenient distributing points. Write for sample and further facts.

THE PHILIP CAREY CO.
10 Wayne Ave., Lockland
Cincinnati, Ohio

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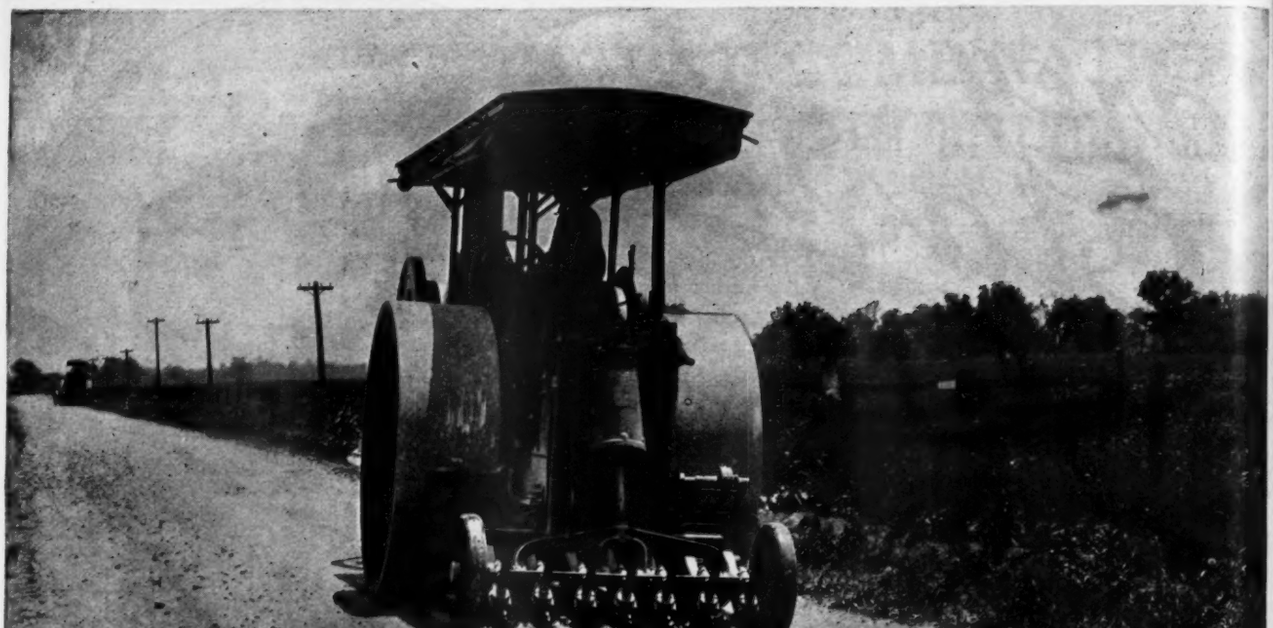

Buffalo-Springfield Rollers

The Economy of Upkeep

Appeals to the Experienced Roller Buyer

Buffalo-Springfield Rollers perform in the most satisfactory manner a wide variety of work in connection with the construction and maintenance of all classes of roads and streets. Their real worth is proved by the fact that nearly one-half of these machines now purchased are on repeat orders from old customers who have had full opportunity to become familiar with the relative merits of road machinery.

In the manufacture of these rollers, nothing is left undone that can contribute to their utility, long life, economy and convenience in operation.

Get full particulars regarding them.

"Buffalo" and "Kelly-Springfield" Quality Rollers

Manufactured in all types and sizes, steam and motor, by

The Buffalo-Springfield Roller Co.

Springfield **Ohio**

BUYERS' CLASSIFIED DIRECTORY

of Names of Firms from Whom to Buy Material, Appliances and Machinery Needed by Public Works Departments and Contractors

CONTRACTORS' EQUIPMENT

(See Paving Machinery also)

Asphalt Block Press
Nat'l Moulding Press Corp.

Air Compressors
Ingersoll-Rand Co.
Schramm, Chris. D., & Son
Sullivan Mchy. Co.

Air Compressors, Portable
Ingersoll-Rand Co.

Ash Handling Mach.
Blaw-Knox Co.

Angle Splice Bars
Sweet's Steel Co.

Asphalt Block Press
Nat'l Moulding Press Corp.

Backfillers
Pawling & Harnischfeger Co.

Bar Benders
Ransome Concrete Mach. Co.

Bar Cutters
Ransome Concrete Mach. Co.

Bins
Ransome Concrete Mach. Co.

Blasting Powder
Atlas Powder
Du Pont de Nemours Co.

Bodies, Stake and Rack, Trucks and Trailers
Detroit Trailer Co.

Bodies, Dump (Steel) Trucks and Trailers
Detroit Trailer Co.

Bodies, Gravity Side Dump (Steel)
Detroit Trailer Co.

Bodies, Steel Platform with Wooden Stakes and Racks for Trucks and Trailers
Detroit Trailer Co.

Bolts, Tee Head
Sweet's Steel Co.

Braces, Trench
The Duff Mfg. Co.

Bridges
American Bridge Co.
Blaw-Knox Co.
Russell Grader Mfg. Co.
Truscon Steel Co.

Bridge & Wharf Timbers (Creosoted)
Wyckoff Pipe & Creo. Co., Inc.

Buckets, Automatic & Dumping
Blaw-Knox Co.
Ransome Concrete Mach. Co.

Buckets, Clam Shell

Dragline, Orange Peel
Blaw-Knox Co.
L. P. Green
Russell Grader Mfg. Co.

Cableways
Flory Mfg. Co.

Cars, Dumping and Industrial
Good Rds. Mchy. Co., Inc.
Koppel Industrial Car & Equipment Co.

Carts, Concrete
Acme Road Mchy. Co.
Columbia Wagon & Body Co.
Ransome Concrete Mach. Co.

Castings
Burch Plow Works Co.
Republic Iron Works
South Bend Foundry Co.
U. S. Cast Iron Pipe & Foundry Co.

Caterpillar Tractors
Holt Mfg. Co., Inc.

Chutes, Concrete
Ransome Concrete Mach. Co.
U. S. Cast Iron Pipe & Foundry Co.

Clips, Rail, Forged
Sweet's Steel Co.

Concrete Block Machines
Republic Iron Works

Conduits (Creosoted)
Wyckoff Pipe & Creo. Co., Inc.

Cranes, Locomotive
Ball Engine Co.
Erie Steam Shovel Co.
Koehring Co.
Orton & Steinbrenner
Pawling & Harnischfeger Co.

Cranes and Hoists
S. Flory Mfg. Co.
Pawling & Harnischfeger Co.

Cross-Arms (Creosoted)
Wyckoff Pipe & Creo. Co., Inc.

Cross-Ties (Creosoted)
Wyckoff Pipe & Creo. Co., Inc.

Crushers
Acme Road Mchy. Co.
Good Rds. Mchy. Co., Inc.

Dinkeys
Koppel Industrial Car & Equipment Co.

Ditchers and Graders
Russell Grader Mfg. Co.

Drills
Ingersoll-Rand Co.
Schramm, Chris. D., & Son
Sullivan Mchy. Co.

Dump Bodies, Steel
Columbia Wagon & Body Co.
Heil Co., The
Mandt Body Co.

Dump Bodies and Hand Hoists—Ford, Reo and other light trucks
Detroit Trailer Co.

Dump Wagons
Acme Road Mchy. Co.
Austin-West. Rd. Mach. Co.
Good Rds. Mchy. Co., Inc.
Heil Co., The
Standard Steel Wks.
Tiffin Wagon Co.

Engines
Avery Co.
Flory Mfg. Co.
Schramm, Chris. D., & Son

Excavators
Ball Engine Co.
Blaw-Knox Co.
Erie Steam Shovel Co.
L. P. Green
Koehring Co.
Osgood Co.
Pawling & Harnischfeger Co.

Explosives
Atlas Powder Co.
E. I. du Pont de Nemours & Co.

Front Bumpers
Detroit Trailer Co.

Garbage Bodies, for Trucks and Trailers
Detroit Trailer Co.

Hammer Drills
Ingersoll-Rand Co.

Heaters, Asphalt & Tar
Connery & Co., Inc.
Farasey, J. D., Mfg. Co.
Honhorst, Jos., Co.

Hoists
Ingersoll-Rand Co.
S. Flory Mfg. Co.
Pawling & Harnischfeger Co.
Schramm, Chris. D., & Son

Hoists, Hand, for Trucks and Trailers
Detroit Trailer Co.

Hoists, Hydraulic and Hand for Motor Trucks
Heil Co.

Hose
Goodyear Tire & Rubber Co.

Jacks, Lifting
The Duff Mfg. Co.

Kettles, Asphalt & Tar
Connery & Co., Inc.
Honhorst, Jos., Co.

Loading Machines
Conant Machine Co.

Lumber (Creosoted)
Wyckoff Pipe & Creo. Co., Inc.

Metal Lath
Truscon Steel Co.

Motor Trucks
Avery Co.
Tiffin Wagon Co.

Pails
Rochester Can Co.

Paint
Ruberoid Co.
Servicised Products Co.

Paving Mixers
Koehring Co.
Ransome Concrete Mach. Co.

Picks
Wyoming Shovel Works

Piles (Creosoted)
Wyckoff Pipe & Creo. Co., Inc.

Pintle Hooks
Detroit Trailer Co.

Plain Splice Bars
Sweet's Steel Co.

Plows
Avery Co.
Burch Plow Works Co.
Russell Grader Mfg. Co.
Wiard Plow Co.

Pneumatic Concrete Mixers and Placers
Ransome Concrete Mach. Co.

Pneumatic Tools
Ingersoll-Rand Co.

Poles (Creosoted)
Wyckoff Pipe & Creo. Co., Inc.

Pumps
Aurora Pump & Mfg. Co.
De Laval Steam Turbine Co.
Emerson Pump & Valve Co.
Ingersoll-Rand Co.
Schramm, Chris. D., & Son

Radiator Guards (Trucks)
Detroit Trailer Co.

Rails, Light and Heavy Steel
Sweet's Steel Co.

Reinforcing Steel
Truscon Steel Co.

Rock Drills
Ingersoll-Rand Co.

Sharpeners
Ingersoll-Rand Co.

Shovels
Rochester Can Co.
Wyoming Shovel Works

Snow Removal Outfits
Avery Co.
Holt Mfg. Co., Inc.
Russell Grader Mfg. Co.

Spikes, Railroad
Sweet's Steel Co.

Standard Steel Buildings
Truscon Steel Co.

Steam Shovels
Ball Engine Co.
Erie Steam Shovel Co.

Switches
Koppel Industrial Car & Equipment Co.

Steel Cross Ties
Sweet's Steel Co.

Tires
Goodyear Tire & Rubber Co.

Tow Hooks (Trucks)
Detroit Trailer Co.

Track
Koppel Industrial Car & Equipment Co.
Sweet's Steel Co.

Tractors
Holt Mfg. Co.

Trailers
Detroit Trailer Co.
Smith & Sons Mfg. Co.

Trailer Attachments
Detroit Trailer Co.

Trailer Hitches
Detroit Trailer Co.

Trailer Hooks
Detroit Trailer Co.

Track Bolts
Sweet's Steel Co.

Trucks, Commercial
The Hug Co.
Tiffin Wagon Co.

Turn Tables
American Bridge Co.
The Hug Co.
Western Structural Co.

DANGER SIGNALS

Ingram-Richardson Mfg. Co.

FIRE DEPARTMENT EQUIPMENT

Combination Chemical and Hose Wagons
American-La France Fire Engine Co.

Fire Alarm System
Loper Fire Alarm Co.

Fire and Chemical Hose
Goodyear Tire & Rubber Co.

Pails
Rochester Can Co.

Pumping Engines Gasoline
American-La France Fire Eng. Co.
De Laval Steam Turbine Co.

Tires
Goodyear Tire & Rubber Co.

Triple Combination Motor
American-La France Fire Engine Co.

Underwriters' Pumps
De Laval Steam Turbine Co.

MISCELLANEOUS

Drawing Materials
F. Weber Co.

Engineering Supplies
F. Weber Co.

Tanks, Welded Steel
Heil Co.

Transits and Levels
F. Weber Co.

PAVING AND ROAD MACHINERY

Air Compressors, Portable
Ingersoll-Rand Co.

Asphalt Block Press
Nat'l Moulding Press Corp.

Asphalt Distributors
Cressy Road Sprayer Mfg. Co.
Etnyre, E. D., Co.

Asphalt Plants
Cummer & Son Co.
Farasey, J. D., Mfg. Co.
Hetherington & Berner
Warren Bros. Co.

Car Unloaders
Acme Road Mchy. Co.
Burch Plow Works Co.
Good Rds. Mchy. Co., Inc.

Concrete Mixers
Good Rds. Mchy. Co., Inc.
Jaeger Mch. Co., The
Koehring Co.
Ransome Concrete Mach. Co.
Republic Iron Works
Schramm, Chris. D., & Son

Culverts, Corrugated Metal
Newport Culvert Co.

Gravel Screening Plants and Loaders
L. P. Green
Russell Grader Mfg. Co.

Heaters
Honhorst, Jos., Co.

Oil Distributors and Sprayers
Acme Road Mach. Co.
Austin-West. Rd. Mach. Co.
Connery & Co., Inc.
Cressy Road Sprayer Mfg. Co.
Etnyre, E. D., Co.
Good Rds. Mchy. Co., Inc.
The Kinney Mfg. Co.

Paving Breakers
Ingersoll-Rand Co.

Picks
Wyoming Shovel Works

Pumps—Oil and Asphalt
The Kinney Mfg. Co.

Road Graders
Acme Road Mchy. Co.
Austin-West. Rd. Mach. Co.
Ball Engine Co.
Erie Steam Shovel Co.
Good Rds. Mchy. Co., Inc.
Russell Grader Mfg. Co.

Road Drags
Acme Road Mchy. Co.
Austin-West. Rd. Mach. Co.
Good Rds. Mchy. Co., Inc.
Russell Grader Mfg. Co.

Road Levellers
Holt Mfg. Co., Inc.

Road Maintainers
Avery Co.
Austin-West. Rd. Mach. Co.
Russell Grader Mfg. Co.

Road Pavement

Testing Machines
Ingersoll-Rand Co.

Road Rollers
Acme Road Mchy. Co.
Avery Co.
Austin-West. Rd. Mach. Co.
Buffalo-Springfield Rol. Co.
Good Rds. Mchy. Co., Inc.

Rock Crushers
Acme Road Mchy. Co.
Austin-West. Rd. Mach. Co.
Good Rds. Mchy. Co., Inc.

Rock Drills
Ingersoll-Rand Co.
Schramm, Chris. D., & Son
Sullivan Mchy. Co.

Motor Tandem Rollers
Austin-West. Rd. Mach. Co.

Scarifiers
Acme Road Mchy. Co.
Austin-West. Rd. Mach. Co.
Avery Co.
Buffalo-Springfield Rol. Co.
Good Rds. Mchy. Co., Inc.
The Hug Co.
Russell Grader Mfg. Co.

Scrapers
Acme Road Mchy. Co.
Austin-West. Rd. Mach. Co.
L. P. Green
Good Rds. Mchy. Co., Inc.
Root Spring Scraper Co.
Russell Grader Mfg. Co.
Smith & Sons Mfg. Co.

Screens
Acme Road Mach. Co.
Good Rds. Mchy. Co., Inc.
L. P. Green
Russell Grader Mfg. Co.

Shovels
Rochester Can Co.
Wyoming Shovel Works

Spreaders
Acme Road Mach. Co.
Burch Plow Works Co.

Steel Forms
Heltzel Steel Form & Iron Works
Standard Steel Works

Tar Kettles, Asphalt Heaters, etc.
Acme Road Mchy. Co.
Connery & Co., Inc.
Cressy Road Sprayer Mfg. Co.
Honhorst, Jos., Co.
The Kinney Mfg. Co.
Standard Steel Works
Warren Bros. Co.

Tractors
Avery Co.
Holt Mfg. Co., Inc.

Turn Tables
The Hug Co.
Western Structural Co.

Wagon Loaders
Conant Machine Co.

PAVING MATERIALS

Asphalt
Servicised Products Co.
Standard Oil Co. (Ind.)
Standard Oil Co., (N. Y.)
Texas Co.

Binders
Barrett Co., The
Standard Oil Co. (Ind.)
Standard Oil Co., (N. Y.)
Texas Co.

Bituminous Pavements
Barrett Co., The
Texas Co.
Warren Bros. Co.

Contraction Joints
Truscon Steel Co.

Creosoted Wood Block
Republic Creo. Co.
Wyckoff Pipe & Creo. Co., Inc.

Culverts, Corrugated Metal
Newport Culvert Co.

Curb Bars
Truscon Steel Co.

Expansion Joints
Barrett Co., The
Philip Carey Co.
Servicised Products Co.
Truscon Steel Co.

Fluxing Asphaltums
Standard Oil Co. (Ind.)

Oil (Roads)
Barrett Co., The
Headley Good Roads Co.
Standard Oil Co. (Ind.)
Standard Oil Co. (N. Y.)
Texas Co.

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Paving Fillers
Standard Oil Co. (Ind.)

Reinforcing Mesh
Truscon Steel Co.

SEWERAGE

Culverts
Burch Plow Works Co.
The Robinson Clay Prod.
Russell Grader Mfg. Co.

Culverts, Corrugated Metal
Newport Culvert Co.

Drain Tile
Robinson Clay Prod. Co.

Flush Tank Siphons
Pacific Flush-Tank Co.

Inlet Basins
Flockhart Foundry Co.

Joint Compound (Bituminous)
Ruberoid Co.

Manhole Heads
Flockhart Foundry Co.

Pipe (Cast Iron)
Nat'l Cast Iron Pipe Co.
U. S. Cast Iron Pipe & Fdry. Co.
R. D. Wood & Co.

Pipe Cleaning Machines
W. H. Stewart

Pipe (Reinfr. Concrete)
Independent Con. Pipe Co.

Pumps
Aurora Pump & Mfg. Co.
De Laval Steam Turbine Co.

Rods
The F. Bissell Co.
W. H. Stewart

Segment Block Sewer
Robinson Clay Prod. Co.

Sewage Disposal Apparatus
Direct Oxidation Disposal Corp.
Pacific Flush-Tank Co.

Sewage Disposal Plants
Direct Oxidation Disposal Corp.
Sanitation Corporation

Sewage Disinfection
Dirct Oxidation Disposal Corp.
Electro Bleaching Gas Co.

Sewage Ejectors
Pacific Flush-Tank Co.

Sewage Pumps
De Laval Steam Turbine Co.

Sewer Joint Compounds
G. K. Sales Agency
Pacific Flush-Tank Co.

Sewer Castings
Flockhart Foundry Co.

Vitrified Fire Clay Sewer Tiles
East Ohio Sewer Pipe Co.
Robinson Clay Prod. Co.

Vitrified Sewer Pipe
Eastern Clay Products Association
East Ohio Sewer Pipe Co.
Ohio Vitrified Pipe Co.
Robinson Clay Prod. Co.

STREET CLEANING AND REFUSE DISPOSAL

Ash Bodies
Heil Co.

Ash Cans
Rochester Can Co.

Carts
Acme Road Mchy. Co.
Columbia Wagon & Body Co
Tiffin Wagon Co.

Garbage Bodies, Steel
Columbia Wagon & Body Co.
Heil Co., The

Incinerators
Stacy-Bates Co.
Vulcan Incinerator Co.

Manholes—Catch Basins
Burch Plow Works Co.
Wm. E. Dee Co.
South Bend Foundry Co.

Shovels
Rochester Can Co.
Wyoming Shovel Works

Sprinkling Wagons and Flushers
Austin-West. Rd. Mach. Co.
Good Rds. Mchy. Co., Inc.
The Kinney Mfg. Co.
Tiffin Wagon Co.

Street Flushing Hose
Goodyear Tire & Rubber Co.

Street Scrapers
Rochester Can Co.

Street Sweepers
Austin-West. Rd. Mach. Co.
Ohio Municipal Equip. Co.

STREET SIGNS

Ingram-Richardson Co.

WATER WORKS

Air Compressors
Ingersoll-Rand Co.
Schramm, Chris. D., & Son
Sullivan Machy. Co.

Air Lift
Ingersoll-Rand Co.

Brass Water Connection
Mueller, H., Mfg. Co.

Centrifugal Pumps
Aurora Pump & Mfg. Co.
De Laval Steam Turbine Co.

Chloride of Lime
Penn Salt Mfg. Co.

Chlorine Liquid
Electro Bleaching Gas. Co.

Deep Well Drills
Ingersoll-Rand Co.

Deep Well Pumps
Aurora Pump & Mfg. Co.
Cook, A. D.
Ingersoll-Rand Co.

Disinfecting Chemicals
Electro Bleaching Gas Co.
Penn Salt Mfg. Co.

Filters
N. Y. Continental Jewel Filtration Co.

Filtration Plants
Norwood Engineering Co.

Filter Alum
Du Pont de Nemours Co.

Fire Hydrants
Clark Co., H. W.
R. D. Wood & Co.

Flap Valves
Coldwell-Wilcox Co.

Meters
Badger Meter Mfg. Co.
Clark Co., H. W.
Hersey Mfg. Co.
Pittsburgh Meter Co.
Thompson Meter Co.
Union Water Meter Co.

Meter Boxes
H. W. Clark Co.
Pittsburgh Meter Co.

Meter Testing Machines
H. W. Clark Co.
Mueller, H., Mfg. Co.
Pittsburgh Meter Co.

Pipe, Cast Iron
National Cast Iron Pipe Co.
U. S. Cast Iron Pipe & Fdy. Co.

Pipe, Steel
East Jersey Pipe Co.

Pipe, Wood
A. Wyckoff & Son Co.
Wyckoff Pipe & Creo. Co., Inc.

Pumps
Aurora Pump & Mfg. Co.
H. W. Clark Co.
Cook, A. D.
Dayton-Dowd Co.
De Laval Steam Turbine Co.
Schramm, Chris. D., & Son
Sullivan Mchy. Co.

Pumping Engines
De Laval Steam Turbine Co.
Schramm, Chris. D., & Son
Sterling Engine Co.

Screens for Wells
Cook, A. D.

Service Boxes
Mueller, H., Mfg. Co.

Shear Valves
Coldwell-Wilcox Co.

Sleeves and Valves
Mueller, H., Mfg. Co.
Smith, A. P., Mfg. Co.

Sluice Gates
Coldwell-Wilcox Co.

Sprinkling and Flushing Hydrants
Mueller, H., Mfg. Co.

Steel Stacks
Heil Co., The
Honhorst, Jos., Co.

Strainers
Cook, A. D.

Tanks
Farasey, J. D., Mfg. Co.
Heil Co., The
Honhorst, Jos., Co.

Tanks, Towers, Standpipes
Connery & Co., Inc.
Farasey, J. D., Mfg. Co.

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Mueller, H., Mfg. Co.
Smith, A. P., Mfg. Co.

Tunnel Liner Plates
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Valves
Clark Co., H. W.
Mueller, H., Mfg. Co.

Vitrified Pipe
Eastern Clay Products Association

Water Main Cleaning
National Water Main Cleaning Co.

Water Purification
Electro Bleaching Gas Co.
N. Y. Continental Jewel Filtration Co.

Water Sterilization
Electro Bleach Gas Co.

Water Strainers
Mueller, H., Mfg. Co.

Water Supply from Well Systems
Cook, A. D.
Heil Co., The

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TEXAS AND TEXACO

Texaco Sheet Asphalt on Beaumont-Port Arthur Road, Texas. Photo taken after five years' service—no maintenance.

Interest in the Lone Star State centers about its importance in the petroleum industry;—its vast area which is greater than the combined area of the Atlantic Coast States from Maine to Virginia;—its great railroad system which represents a mileage exceeding that of any other State;—its extensive agricultural lands;—and possibly the tremendous scale on which ranching and grazing is carried on in the State.

Texaco Asphaltic Concrete on St. Francis Road, Potter County, Texas—three miles. (Potter County has let contract for another twenty.)

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